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SOME RECENT MECHANICAL COAL STORAGE PLANTS.

By WILBUR G. HUDSON,* M. Am. Soc. M. E.

Provision for storing a portion of the annual production of coal is now generally regarded as of considerable importance. Ample reserve storage of coal is a powerful antidote for the business hesitation and restraint attendant upon fear of strikes, car shortage, increasing demand with inelastic supply, and the like, with their resultant feverish price fluctuations. The "Coal Trade Bulletin," an authority of note, observed, on one occasion:

> The anthracite production of 1906 rounds out more than 5,000,000 tons short of 1905, due almost entirely to the suspension in April and part of May. There has been felt all the year a restraint due to the irregularity of the business, caused by car shortage, lack of bottoms, labor troubles in certain fields, and a labor shortage, that hampered the operators to a degree. Fear of strikes, early in the year, which led to stocking of fuel by consumers, stagnation in the markets following the wage agreements and the inability of the railroads to handle the coal offered made trade so uncertain that operators generally were subjected to worries and stoppages when their mines should have been working full time. In most fields where suspensions took place through strikes in April, their resumption saw a great rush of production. This is remarkable, because the active fields had absorbed much of the market of those thrown idle.
>
> Prices during the year reflected at all stages the state of the mining industry, and the manner in which deliveries could be made. At the opening of the year, there was firm tone. During the strikes and when work was once more resumed, there came a stagnation, and prices on anthracite, bituminous and coke were almost at bottom figures. When the demands of the miners, both anthracite and bituminous were presented to the operators, prices took a drop, and markets were at a standstill.

Some idea of the effort to counteract these pernicious influences is shown by the following tabulation, which exhibits the relationship between the annual production of anthracite coal in 1906 by the large railway and mining corporations of Pennsylvania, and the capacities of their mechanically-operated storage plants:

Company.	Storage capacity. Tons.	Shipments in 1906. Tons.	Perc't'ge of storage to shipments.
Lehigh Valley	1,140,000	8,536,250	13.3
Phila. & Reading	680,000	11,258,300	6.0
Del., Lack. & West'n.	200,000	9,201,375	2.2
Pennsylvania	880,000	4,856,000	18.1
Delaware & Hudson	390,000	5,346,600	7.3
C. R. R. New Jersey.	560,000	6,983,000	8.0
N. Y., Ont. & West'n.	180,000	2,445,000	7.3
Erie	545,000	5,636,600	9.7
Total	4,575,000	54,263,625	8.3

As the rated capacities of the plants may be exceeded about 25% by chuting, etc., it may be said that more than 10% of the annual production can be held in storage ready for economical handling in reshipment. Also there is considerable reserve tonnage non-mechanically stored, and we may consider the large amount at any moment in transit as an additional resource. This is a strong factor in discouraging labor agitation, facilitating prompt fulfilment of orders, multiplying the efficiency of cars and, to a considerable extent, tending to overcome the embarrassment of varying demands versus (economically) fixed supply.

The subject must be considered in two aspects: storage by the producer and storage by the consumer. The former prevails in the anthracite industry, while in the bituminous industry the storage is generally on the part of the big consumers. The division into anthracite and bituminous storage is therefore an equivalent, and it is a more proper classification because the differences between the two kinds of coal necessitate radically different types of storage and handling plants.

Anthracite coal can be stored in deep piles with little danger of heating. Commercial conditions require separation of different sizes in storage. The coal in any one pile or compartment is more truly a "granular material" than is a pile of bituminous coal, and for this reason, and because of its hardness, it can be handled successfully with bucket conveyors, scrapers, and the like. At the same time the desired careful sizing of the coal makes it imperative to minimize the breakage which occurs in handling. All these conditions have a different aspect in the case of bituminous

FIG. 1. ANTHRACITE STORAGE PLANT OF THE PHILADELPHIA & READING COAL AND IRON CO., AT ABRAMS, PA.
Capacity, 480,000 tons in eight piles of 60,000 tons.

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coal. This material cannot be stored in very deep piles, but the depth must be limited to about 35 ft., to avoid danger of heating. The material is rarely sized, and the machinery best adapted for handling anthracite is not suited to it.

Anthracite Storage Plants.

For anthracite coal the well-known Dodge system, as built by the Dodge Coal Storage Co., under the patents of Mr. James M. Dodge, has been by far the most extensively installed. All the anthracite producers own one or more plants of this design. The largest is one recently completed for the Philadelphia & Reading Co., at Abrams, near Norristown, Pa.

ABRAMS PLANT.—It is arranged (see Fig. 1) in four groups, each comprising two trimmers of 60,000 tons storage capacity each, a pivoted reloader, a screenings tower and a power plant. Each trimmer stocks out coal at the rate of 300 tons per hour, and the reloader can reload this at 250 tons per hour. At the lower end of the yard (not shown in the photograph) is the boiler house supplying steam for all four groups, and a complete screen house to resize the plant's screenings.

A system of smaller groups is sometimes preferred for increased flexibility and rate of handling. Thus, the plant now in course of construction for the Pennsylvania Railroad near South Amboy, N. J., is arranged for 14 trimmers, each of 15,000 tons capacity, and 7 reloaders. This will give a wide variation in speed, and in the number of sizes and grades of coal that can be stored.

The essential features of the standard Dodge plant are: (1) A pair of trimmer trusses, each equipped with a scraper conveyor whose trough bottom is movable, to facilitate the formation of a conical pile of coal of increasing depth. This is done by gradually increasing the distance the coal is conveyed, so the discharge point is always a little in advance of the peak of the pile, and breakage of coal is reduced to a minimum. (2) A reloading system, consisting of a conveyor with its supporting frame pivoted at one end and provided with suitable mechanism for swinging over the full storage area. There is, also, the reloading tower, a steel structure with stationary or shaking screens, and with provision for spouting the coal into cars. A unit consists of the two trimmers, one reloading system, and the power plant. The trimmers are built up to 60,000 tons capacity each, and by increasing the number of units capacities up to any amount can be provided for.

WENDE PLANT.—Some interesting modifications of the standard design have recently been evolved, notably the Lehigh Valley Co.'s plants at Wende, N. Y., erected in 1905 and at Ransom, near Pittston, Pa., erected in 1906.

The Wende plant adapts the standard Dodge trimmer to covered storage, but differs radically in its reloading system. The exposed location and rigorous climate would lead to increased cost of reloading were the coal stored in the open.

The general arrangement is shown by Fig. 2. The main storage building is a steel arch structure 480 ft. long, 230 ft. wide and 85 ft. high to the top of the three-hinged arch trusses, sheathed with No. 20 corrugated steel, and designed with a factor of safety of four. Two views during the erection of the building are given in Figs. 3 and 4. Timber retaining bulkheads take the entire coal thrust and divide the enclosed area into three compartments, each with a storage capacity of 30,000 tons. The bulkheads are independent of the protecting structure, to allow for adjustment under load. Each compartment is fed by a trimmer with the usual provision for delivering the coal at a gradually increasing height as the apex of the piles rises, to prevent breakage.

In reloading, the coal flows through openings in the floors to a steel overlapping bucket carrier which carries it to the screenings and reloading tower. There are three of these towers each equipped with four shaking screens. The cleaned coal can be reloaded into cars on any one of three reloading tracks. Independent gravity discharge elevators encircle the towers for transferring coal from the home cars to foreign gondolas and box cars. This last is a very valuable feature, as it fixes the circuit of the home cars, even though carrying coal for Western points, merely from the anthracite regions to Buffalo and return.

Coal can be stocked with each trimmer conveyor or reloaded from each compartment at a guaranteed speed of 150 tons per hour. Most of it is tributary to the reloading gates by gravity, and the rest is brought to the gates by power scrapers.

RANSOM PLANT.—The Ransom plant has several novel features and is a unique departure from its prototype. Fig. 5 is a general elevation and plan, and Figs. 6, 7 and 8 give views more in detail.

A steel trestle or colonnade, 900 ft. long and 80 ft. high supports the upper end of a 200-ft. standard Dodge trimmer truss, whose lower end rests upon a four-wheeled truck. The supporting trestle consists of a series of cylindrical steel columns of 30 ins. outside diameter, built up of ½-in. plates. The columns are pin-connected at the bottom to cast steel footings and filled with concrete. Each is guyed against wind pressure by two ⅞-in. steel cables. Longitudinal stiffness is given by the cross bracing of the centre pair of columns, as shown in Fig. 6. Upon their upper ends rests the girder forming the track or runway for the upper truck of trimmer. The trimmer truss may be shifted along the runway at a speed of 40 ft. per min. by means of a 50-HP. motor of street railway type, geared to both head and foot trucks. The trough of the conveyor has a movable bottom, as already described, to lessen breakage by keeping the fall of coal as small as possible.

Paralleling the runway is a wood trestle with a series of bins. Upon this trestle are run the loaded railway cars, which can thus be emptied independently of the position of the trimmer, if need be. The attendant stationed in the cabin at the foot of the truss has control of all the movements of the stocking out machinery, operates the bin gates, shifts the truss, starts and stops the conveyor, etc. This arrangement gives remarkably rapid and economical operation. The trimmer has on several occasions stocked out 3,800 tons in 9 hours. The total storage capacity in a continuous pile is 383,000 tons.

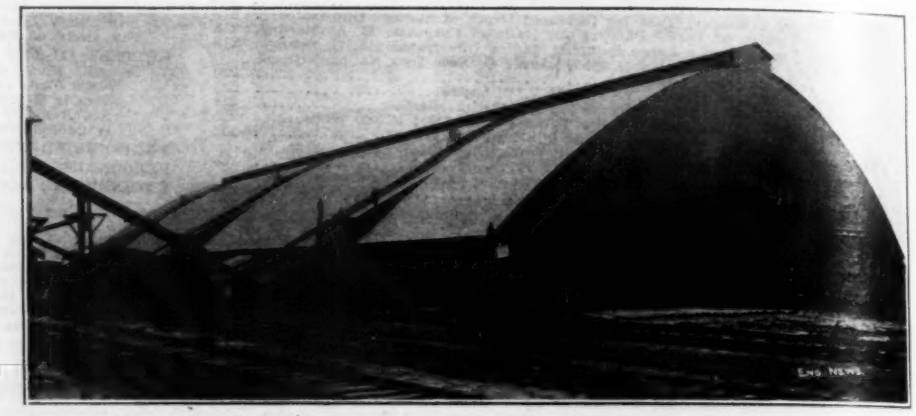
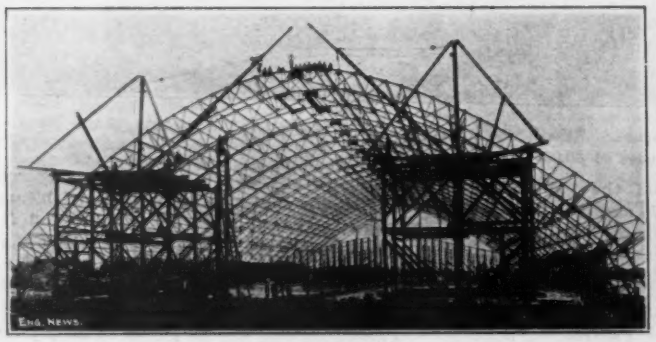
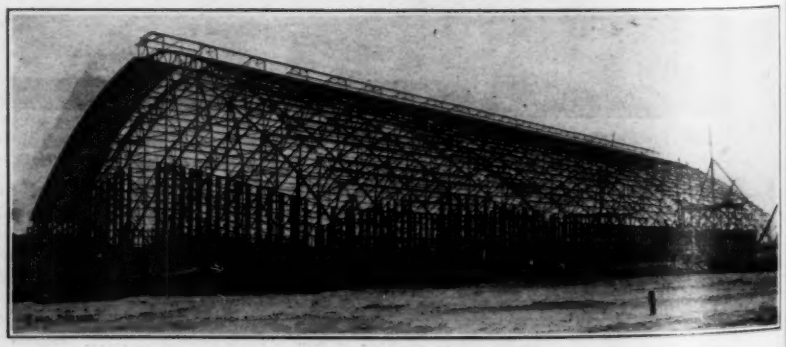


FIG. 2. COVERED ANTHRACITE STORAGE PLANT AT WENDE, N. Y., LEHIGH VALLEY R. R.

The reloading operation is as follows: The greater part of the stored coal is reloaded by gravity to two Link-Belt flight conveyors running in longitudinal tunnels directly beneath the steel trestle, which deliver into a Link-Belt V-bucket conveyor discharging at the top of the screening and reloading tower. For the coal out of reach of direct gravitational feed there are traversing reloaders, which are quite similar to the standard Dodge reloader, except that they traverse in a right line instead of being pivoted at one end. (See Fig. 8.) Each is formed by a steel frame 170 ft. long, with an encircling reversible conveyor driven by a 45-HP. motor. Traversing is effected by a 60-HP. motor connected to suitable winding mechanism for overhauling cables laid along the storage area. Each reloader has a capacity of 150 tons per hour. They discharge into the tunnel flight conveyors before mentioned.

As at Wende, the reloading tower is encircled by an elevator to facilitate the transfer of coal from hopper-bottom cars to box cars, but this operation is facilitated by means of a Smith Box Car Loader. The employment of this loader in conjunction with the reloading scheme of a storage plant is a novel and valuable feature. Every shipper experiences the embarrassment of being forced to load into box cars at times. The installation of suitable apparatus for doing this economically at each shipping point would be expensive, and its logical location is at the storage plant. The cost of loading box cars with this machine is found to be but slightly in excess of





FIGS. 3 AND 4. TWO VIEWS OF WENDE COAL-STORAGE SHED, DURING CONSTRUCTION.

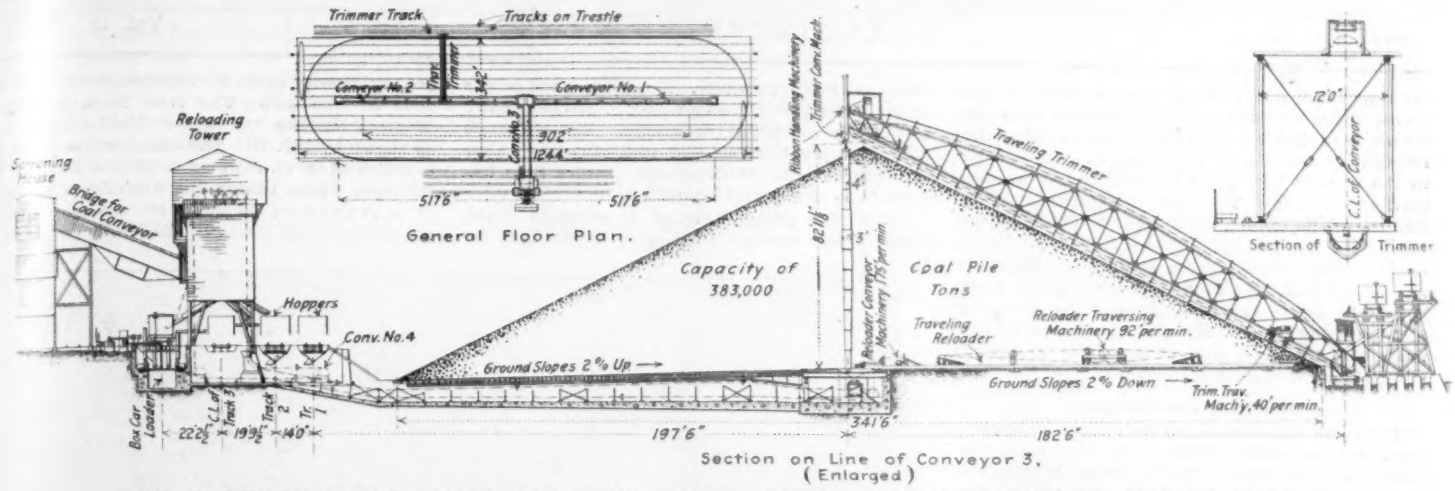


FIG. 5. GENERAL ELEVATION AND PLAN OF ANTHRACITE STORAGE PLANT AT RANSOM, PA., LEHIGH VALLEY R. R.

the usual cost for gondolas, and the operation is practically as expeditious.

The machine at Ransom consists of an oscillating cradle with the hydraulic mechanism for operating it. When the empty car is in position on this cradle the axis of rotation is on a line connecting the centers of the two car-door apertures. Power-operated clamps lock the car into position, the loading chute is extended into the door-way, which has been previously bulk-headed to a height of about 3 ft., and loading is commenced. As the crest of the coal pile reaches the chute, the cradle is slowly revolved, lowering one end of the car, and the coal flows gently over the pile already formed, until that end is filled. The cradle is then reversed and the opposite end of the car similarly loaded. It would appear at first thought that the coal already loaded would shift to the other end as the position of the car is reversed, but owing to the difference in the angle required to start coal from rest over that required to maintain the motion of moving coal, there is practically no shifting of the load. Finally, the cradle is brought back to an even keel, the clamps released from the car, and the next empty car pushes it onward. The whole operation is simple and rapid. Box cars can thus be taken care of at one shipping point, where the organization and equipment assure economical loading.

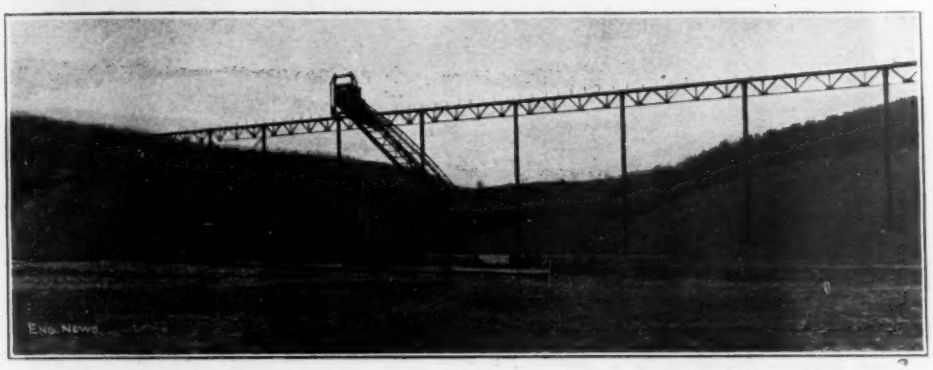


FIG. 6. TRIMMER SUPPORTING TRESTLE, RANSOM PLANT.

The plant just described is particularly well designed for large capacities. The coal being stored in a continuous pile, we have a maximum of storage for the ground space covered. It lends itself readily to later extension at comparatively small expense. Another valuable feature is the concentration of the reloading operations at one point, permitting the employment of a complete screenings plant, box car loader and transfer, all conveniently located for supervision by a single squad of men. As compared with the standard Dodge plant, it is more economical of ground-space, but less flexible in handling coal of several sizes. This is a matter which must be taken into careful consideration in the design of an anthracite plant, viz., the choice of type. Prospective conditions varying widely must govern and decide whether the proper design is to be a single unit of large capacity, or a multiplicity of smaller independent units.

FUNDAMENTALS OF ANTHRACITE STORAGE.—The elements involved in good design in anthracite storage plants are: small percentage of breakage of coal; economic operation; provisions for screening and resizing coal, and a yard of track system that permits movement of a great number of cars without congestion and interference.

(1) Every free fall means so much breakage. In each of the designs described in the foregoing the endeavor has been made to handle the coal gently and smoothly. The trimmers deliver always a little ahead of the growing pile, and the reloaders take advantage as far as possible of the peculiar slow avalanching movement of sized anthracite.

(2) In the standard Dodge plants a labor cost of 1½ cts. per ton for handling coal each way is not unusual, and a common guarantee is that the total cost of loading, including all labor, repairs and maintenance, shall not exceed 5 cts. per ton moved. The writer has not the cost of handling coal in the new Wende and Ransom plants, but the expectation is that these will not vary widely from the results attained in the standard Dodge plants. In the Ransom plant especially, the large capacity of the trimmer and the fact that coal can be unloaded into the trestle bins to a considerable extent independently of the trimmer will mean a very low cost of putting coal into storage.

(3) Provision for rescreening and resizing is a necessity. Considerable undersize coal is received from the cars and some breakage must, inevitably, occur in its passage through the plant. The writer recalls one instance in which the screenings were sold as such, until it was found by investigation that no less than 70% of the so-called screenings were recoverable by rescreening as sized coal, and a very large leak was promptly stopped.

(4) The plant capacity is far below the combined capacities of its trimmer or reloader conveyors unless the track system is adequate. Note

FIG. 7. LOWER END OF TRIMMER, AT RANSOM PLANT, SHOWING ALSO TRESTLE BINS AND OPERATOR'S HOUSE.

in Fig. 1 the admirable system at the Abrams plant. Here we have a central through track, on each side of which are the tracks for dumping and reloading. Outside of these again, and nearest to the storage floors, are the tracks for cars receiving screenings. There are frequent cross-overs, and the whole is on a 1¼% grade to facilitate car movement by gravity. Where it is not practicable to have the tracks on a grade a cable haulage is installed. At each end of the plant there should be ample space for storing the incoming and outgoing cars. No one thing contributes more to raising the cost of operating a storage plant than insufficient railway yard space.

Bituminous Coal Storage.

Storage of bituminous coal introduces new problems, as previously noted, and the foregoing plants are not adapted to handling bituminous coal. The depth of pile would almost certainly cause spontaneous combustion or decomposition, and the reloaders could not work to advantage in this coal. The design, therefore, should provide for storage in a mass of even depth—fixed by its liability to decomposition under pressure.

Bituminous coal operations involve the handling of a more or less uniform product, and, to a certain extent, the supply can be adapted to the general demand. Consequently, storage plants for this coal are met with chiefly at the works of the consumer, giving a reservoir which eases off the variations between the deliveries of fuel to him and the demands of his furnaces.

It must be thoroughly understood that these conditions differ radically from those leading to the storage of anthracite coal, where the production of certain sizes is unavoidable and independent to a considerable degree of the demand for those sizes. On the one hand a varying demand with a supply readily controllable, on the other a quite constant demand with, as regards the respective sizes, a troublesome uncontrollable supply. Taking, for example, the steam sizes of anthracite, which compete directly with bituminous coal, their production is quite independent of their market, and, unless they can be readily stored, economic adjustment is impossible.

The best all-round machine for handling bituminous coal is the bridge-tramway, either pivoted or arranged to traverse, and operating a self-filling grab bucket of two to five tons capacity. Equipped for either steam or electric power, this forms a remarkably efficient machine. A fair day's work is 1,500 tons in ten hours. The labor cost of handling should average 1 ct. per ton, and the total cost of handling, i. e.,—power, labor, repairs, supplies and maintenance will not exceed 3 cts. per ton.

street railway type motor. Mounted on the trucks of the outer tower are two 30-HP. street railway motors for swinging the bridge. The design is such that the hoisting and trolleying operations are independent. Without this feature it is impossible to secure rapid handling.

The bridge swings through a complete circle, giving a safe storage capacity of 100,000 tons for

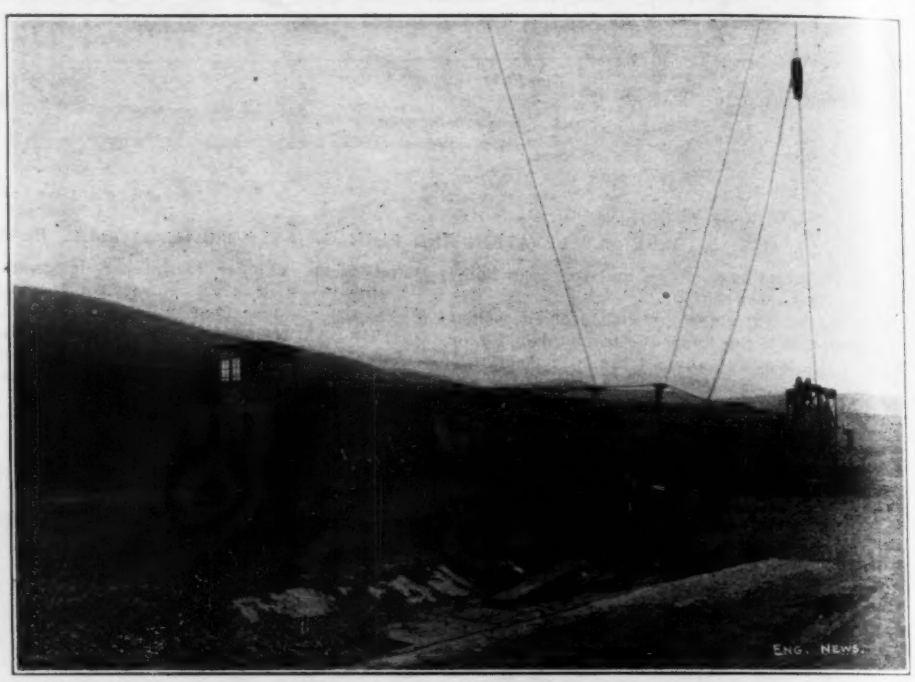


FIG. 8. ONE OF THE TRAVERSING RELOADERS OF THE RANSOM PLANT.

30-ft. depth of pile. Coal is received from two track hoppers delivering to a central pit with ample working clearance. In reloading, the coal is delivered by the automatic bucket directly into cars placed on the track adjacent to the storage pile.

The controller for the hoisting machine consists of two essential parts, the master controller, operated by a foot pedal, and a switch panel with the required solenoids and resistances. As the operator shifts the controller lever, it closes the circuit energizing the successive solenoid switches regulating the main current by grid resistances. The master controller operates through a dash pot so arranged that it is impossible to start the hoisting motor faster than has been found good practice.

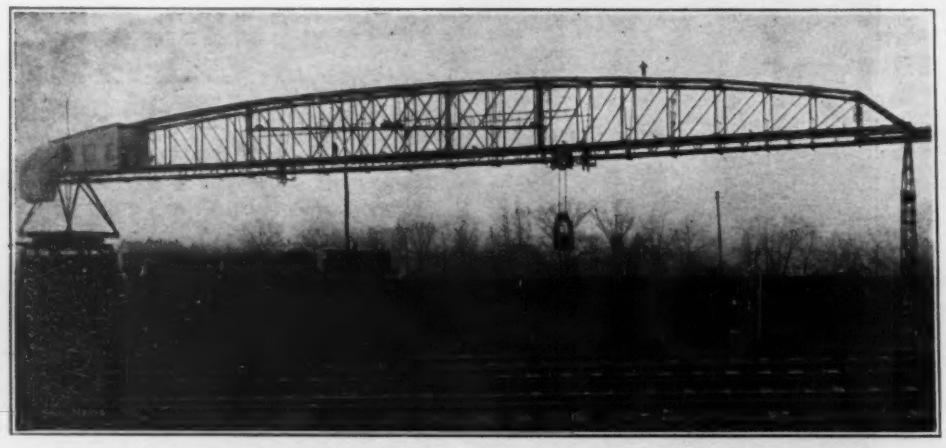


FIG. 9. PIVOTED BRIDGE TRAMWAY FOR 100,000-TON CAPACITY BITUMINOUS COAL STORAGE PLANT, SPAN 280 FT.; ATLAS PORTLAND CEMENT CO., NORTHAMPTON, PA.

ATLAS PLANT.—As an illustration of the pivoted tramway refer to Fig. 9, showing the coal storage plant erected for the Atlas Portland Cement Co., at Northampton, Pa., in 1906. This bridge is 280 ft. from pivot to outer supporting tower. A 2-ton automatic bucket is operated by a 100-HP. 500-volt direct-current motor, with multiple solenoid controller. The horizontal or trolleying movement is taken care of by a 50-HP.

Steam instead of electric power is, of course, suitable for operating a bridge tramway. The local conditions would govern the choice of power.

MIDDLETOWN PLANT.—The locomotive crane is often advantageously used, equipped with long boom and 1-ton grab bucket, operating at a maximum radius of 60 or 80 ft. A comparatively inexpensive storage plant of considerable capacity can thus be arranged. The New York, Ontario & Western Ry. has one such at Middletown, N. Y., as shown by Fig. 10. The crane, whose boom has a radius of 60 ft. rests on a circular track of 16-ft. gage, whose center line describes a circle 60 ft. in radius with the dump pit as a center. This provides a ready storage of 25,000 tons with 25-ft. depth of pile. By having the trucks swivelled, a succession of circular tracks and dumps may be placed to give a very considerable storage capacity.

A. C. L. PLANTS—In an interesting adaptation of this for locomotive coaling stations, the crane is used only for storage, but to serve elevated bins provided with coaling gates. Two of these have just been built for the Atlantic Coast Line Ry., at Waycross, Ga., and South Rocky Mount, N. C. The latter is represented by the views Figs. 11 and 12. They are expected to prove very economical and serviceable, and their actual operating costs will be awaited with interest for comparison with those of locomotive coaling stations of standard design, and trestles. The labor costs of handling coal in standard Link-Belt coaling stations of the best design is about 2 cts. per ton, the total cost of handling including repairs, labor, maintenance and fuel about 4.9 cts. per ton. For coaling stations with crane service the labor cost should be about the same and the total cost of handling somewhat less, as the repairs and maintenance will be lower. With conveyors the majority of repairs is made necessary by foreign material in the coal (timbers, scrap iron, etc.), which would have little or no injurious effect upon a grab bucket.

Among the other large consumers of coal are the coke plants, power plants, lighting and heating plants, etc. With them mechanically operated storage reserves, instead of the obsolete method of laboriously shovelling up a small stock pile which must be more laboriously shovelled back again into cars or carts, are becoming quite common. It means the difference between a cost of 3 to 5 cts. and 25 or 30 cts. per ton handled. The designs are many and varied. We will discuss but two that are interesting.

The new coke plant of the Pennsylvania Steel Co. is equipped with a pivoted electrically-operated bridge tramway with a storage capacity of 100,000 tons, very similar to that already shown in Fig. 9. The bucket has a capacity of two tons. At the pivot of the bridge is a movable hopper. When this is not in use it is shifted to the side and uncovers the central dumping pit into which the cars are unloaded. When in position it de-

livers to a Link-Belt-feeder conveyor, which serves the 30-in. Robins belt conveyor running to the crushing house, where the coal is reduced and foreign material removed by two Bradford breakers, and finally carried to the coke-oven storage bins. Four track hoppers with Link-Belt feeder conveyors are provided, so that coal can be delivered directly to the first 30-in. belt conveyor, a conveyor which will transfer coal when taking from stock directly to the overhead bins. The crane is usually needed but little of the time for stocking out coal, and by substituting a hook-block for the grab-bucket the machine becomes a very valuable addition to the plant for handling miscellaneous material, loading and unloading freight, removing scrap, etc.

FIG. 10. LOCOMOTIVE-CRANE STORAGE PLANT FOR BITUMINOUS COAL AT MIDDLETOWN, N. Y.; NEW YORK, ONTARIO & WESTERN RY.

instead of to storage. The daily consumption of coal will be about 1,500 tons, so the tramway provides for 60 days' operation in the event of an interruption of supply.

The storage plant of the New York Edison Co., at Edgewater, N. J., a very complete plant, is arranged for the storage of 100,000 tons of anthracite and 50,000 tons of bituminous coal as a reserve for its several power houses in New York City. Its general arrangement is shown by the plan, Fig. 13, and the view, Fig. 14.

A steel unloading tower equipped with a 2-ton bucket serves the 30-in. belt conveyors which carry coal back to the two standard Dodge trimmers. The belt conveyor system is reversible, and in reloading carries coal from storage to a swivelled reloading spout in the tower. Bituminous coal is taken care of by the bridge tramway of 200 ft. span, similar to those previously described.

Such a complete plant would be beyond the reach and requirements of a small consumer. Where a moderate storage capacity is required, an inclined conveyor running from beneath a track hopper up over a storage area, with a tunnel conveyor provided for taking coal out of storage, forms an inexpensive plant. Usually, considerable of the coal must be shovelled to the tunnel conveyor, which makes high operating costs. The writer favors the use of a locomotive crane for moderate storage, particularly in connection with

No set rules can be formulated for determining the type of plant best suited to any particular case. The space available, liability to failure of coal supply, the seriousness of such failure, price variations, tonnage burned, and many other considerations enter into the problem, determining usually independently of first cost the proper design, and emphasizing the importance of calling in experienced engineering skill for its solution.

OBSTACLES TO THE EXTENSION OF FOREIGN TRADE IN AMERICAN MACHINERY.

Do American manufacturers desiring to do business abroad neglect the desires of their possible customers in the character of their goods, their methods of packing, consignment, etc., to anything like the extent that would be judged from the reports on the subject made from time to time by various United States consuls? We will not presume to say, but certainly the matter is one deserving attention by many of our readers. Some of the latest statements on this subject, as printed in "Consular and Trade Reports" for Aug. 22 are given below. One of these, which we have abridged somewhat, was made by Consul-General Henry W. Diederich, of Antwerp, as follows:

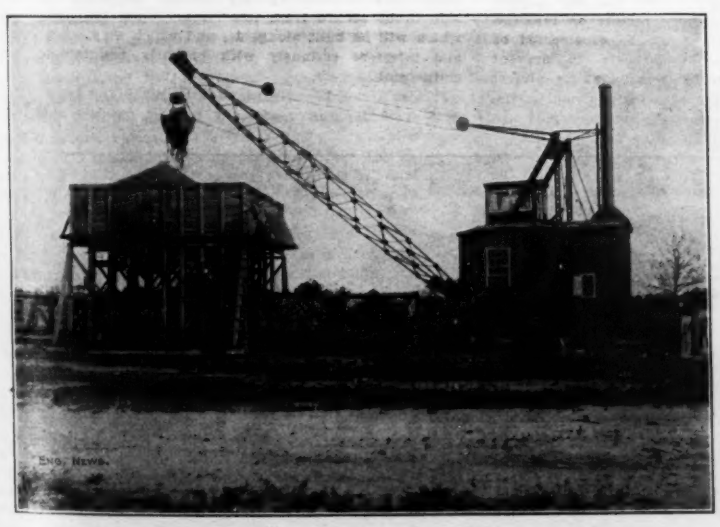
American manufacturers are constantly soliciting new markets in foreign countries through the American consuls, who in turn are earnestly endeavoring to further the interests of American trade. The obstacles in the way, however, are not all on the side of the foreign buyer. According to an inquiry I have instituted on this subject, I find complaints against the methods of American exporters to be quite numerous. There is general objection to the system adopted by many American houses of demanding either a deposit with order or cash against documents, even when shipping goods for the first time and with a desire to capture the market. No foreign house can be induced to buy untried goods by any such methods, no matter how large the prospective profit may be. To demand part payment with order is a condition that is apt to blight the enterprise from the very start.

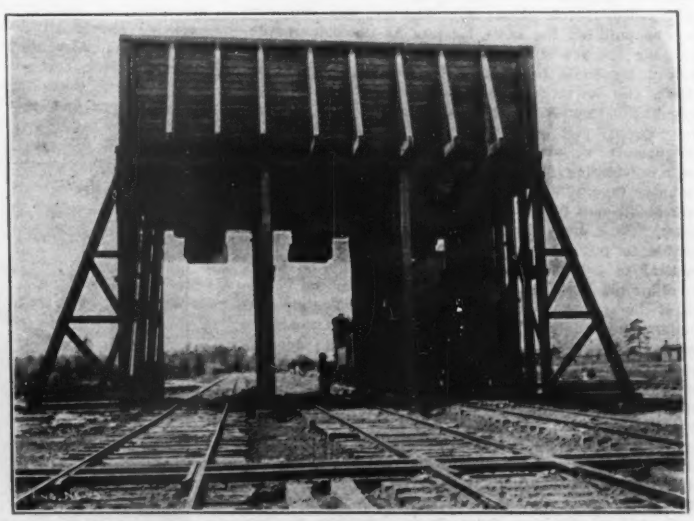
The failure of the American manufacturer to supply goods on time is a subject of frequent complaint. The books of the largest importer of American machinery, machine tools, and machine accessories in this consular district were courteously shown me and I found that orders for boat motors, pumps, parts of machinery, etc., given to American manufacturers had not been executed sometimes for periods varying from 4 to 18 months, when the customer had ordered by cable and desired immediate delivery. In a number of such instances of unpardonable delay British houses have been appealed to and the goods were delivered and paid for by the consumer long before the American house thought of executing the original order.

Another very annoying experience that Belgian importers of American goods call my attention to is that little or no care is being given by some of our manufacturers and dealers in executing foreign orders. Shipments of goods are frequently inferior in quality or deficient in number, weight or size, making it impossible to carry out the terms of a contract to deliver.

One phase of the same general subject as is considered in the above quotation is treated specifically by Mr. Albert Halstead, U. S. Consul at Birmingham, in another report published on the date already given. Writing of the attitude of British agriculturists toward American farm implements, Mr. Halstead quotes from an English newspaper, in part as follows:

When two or three decades ago improved tillage and harvesting appliances came so rapidly into use, American and other manufacturers alive to the possibility of development, invaded the country with machines and implements as ingenious and clever as they were light in draft and attractive in appearance. The consequence was that for a time home-made patterns which by comparison were deemed clumsy and ungainly were rejected in favor of the cheaper imported manufactures. This was particularly the case with hay and corn harvesting machinery, in respect to which the American and Canadian makers admittedly had the lead of us for a time. The British makers did not attempt to meet their American rivals on the latter's own ground; they preferred rather to bide their time for their reward. They foresaw from the outset what is now happening. The light but clever competing appliances from the other side of the Atlantic are beginning to lose the preeminence they so quickly established. They are admittedly unsurpassed and probably unequalled in cleverness and simplicity of design, but few of them equal the best British patterns in point of durability. The British manufactures are heavier and somewhat more costly in the first instance, but they are more durable, and farmers have at last had the fact brought home to them that good mowers, reapers, and binders of British make are cheaper in the long run. It must be said, however, that we have learned much from the United States and Canada in both the construction and the use of agricultural machinery, for they have taken the lead in introducing almost every new design of either machine or implement.





FIGS. 11 AND 12. LOCOMOTIVE COALING POCKET AND STORAGE PLANT SERVED BY 60-FT. RADIUS LOCOMOTIVE-CRANE, AT SOUTH ROCKY MOUNT, N. C.; ATLANTIC COAST LINE RY.

CONSTRUCTION OF SECOND TRACK ACCOMPANIED BY REDUCTION OF GRADIENT.*

By H. H. KNOWLTON.†

With the converting of a single track into a double track railway it is almost a necessity to make the gradients the minimum decided upon as allowable for the division in question. If traffic demands a second track it should be built so that it will not be disturbed for many years. With the road planned for a permanent location, and with permanent gradients, the same policy should extend to the details. Bridges should be of permanent character, and highway crossings eliminated by running them under or over the tracks to as great an extent as authorized expenditures will permit. Passing sidings, block stations and station facilities should be provided at places which will insure their not being disturbed within a reasonable length of time.

We will consider that a railway is so well located and the expense of relocation so great, that the new road must be built on the same location as the old. In determining the profile for any division (and each section between terminals for engines should be treated separately), the lowest gradient possible without excessive expenditure should be obtained. Local conditions entirely govern this selection and with the economics of the question we are not dealing. There is one point worth considering in determining the lowest gradient in a country favorable to very little rise and fall. The law requires all cars fitted with safety couplers and with air brakes. On a division where grades are very light it is possible to put more cars on a locomotive than it is practical to haul, although the tonnage may be under the allowable limit. The cause of this is in the operation of the air brakes on a very long train. The air hose couplers may leak a very little, but enough to cause the rear cars to be very slow in releasing after an application. The result of this is that the locomotive and forward part of the train surges forward and tears out some weak drawbar, resulting in serious delay and possibly blocking the road by a derailment. The safety couplers have usually but little motion and consequently the engine is not assisted in starting its train by getting the slack.

The fewer breaks we have in the gradient, the fewer accidents we will have from trains breaking in two. Small humps should be cut down and light sags lifted. With the profile established and the ultimate plan of tracks determined it is then a question of cheapest and best construction. As we are dealing with a busy road (such as one must be before rebuilding it will be attempted) the first consideration must be to plan the handling of the work to give as little interference as possible to traffic. The money spent in proper preparations should result in saving a much larger sum, by providing proper facilities for operation.

Safety must be a prime consideration. If existing passing tracks must be disturbed, temporary sidings must be provided; preferably in locations where they will not be disturbed, at least until the permanent ones can be completed and used. This problem should be solved jointly by the engineer in charge and the trainmaster. A side track properly located will materially assist in hurrying the work, because of removing interference from traffic. Blind sidings should not be permitted. They are unsafe and will cause considerable loss of time to work trains. A regular telegraph office with telephone connections with the outlying switches is the proper arrangement. A liberal use of telephones along the line will result in ready communication which is essential to any piece of construction.

The masonry must be the first part of the permanent work actually constructed and it should be commenced at the earliest possible time and prosecuted vigorously to keep ahead of grading. With the masonry hanging back we have serious interference with grading and if grading is under contract a serious complaint from the contractor will probably be heard. All water ways which are too small should be enlarged, and any in poor condition should either be entirely rebuilt or repaired permanently. Also all bridges should be constructed of material which requires little or no care to prevent deterioration. Concrete is the ideal material for almost all structures and the design of openings under the track should be such as to permit the uninterrupted use of the common cross ties and ballast. The arch is the cheapest structure in most cases and the most economical. The box or concrete girder may be used to good advantage where head room is small. If girders or trusses must be used a concrete deck should be constructed. This permits common labor to make all track repairs, even in case of derailment.

Masonry structures which are below the existing grade line and which must be constructed under the existing track as well as for the new can be best handled by driving a temporary trestle, removing all overlying fill and handling work in same manner as if building a new structure to replace a pile trestle. Such trestles would cost not more than $5 per running foot for each track, allowing credit for deck material recovered, and this cost may be reduced by use of second-hand material. Piling of beech, elm, hickory or other cheap wood should be used, as its only requisite is strength and durability for a year.

In case the new structure rises above the grade of existing tracks, provision should be made for lining such tracks to one side so as to entirely clear the new structure. This will permit completion of all masonry without interruption, and although the temporary arrangements may appear costly, they will prove cheaper than to handle the work a part at a time and to delay completion awaiting a change of location in tracks. If grading has commenced, the banks may be broadened and only a short piece of trestle built. If not, build a trestle all the way for short openings. Curves at points of junction with old alinement should not exceed 6° and temporary work should be good for a speed of at least 30 miles per hour.

Where old structures are long girders or several spans of trusses with a considerable difference of elevation between new and old, the old superstructures may be lined over on pile piers and trestle approaches made. With a small rise only, the existing structures may be raised without change in alinement by providing pile or frame supports. Whatever method is chosen it should not be forgotten that the important thing is to be able to so arrange the temporary structure that the masonry may be completed and the new bridges put in without any delays dependent upon location of tracks.

The first requisite when considering the grading is to select a contractor who will put the work through and complete it with rapidity, and do first-class work not only in handling material, but in making a proper finish on cuts and on fills. It pays to put a premium on good work to insure its completion during dry weather and not have it drag along into winter when it will cost a great deal more to maintain temporary or permanent tracks and when the cost of building and ballasting tracks will be excessive.

At some time during the progress of grading the main track must be placed to one side, both in cuts and on fills, if the old main track has about the same location as one of the new ones. On fills there is but one practical method and that is to broaden the existing fills (with no fear of getting it too broad) and the building of a new main track on its extreme edge or lining the old main track far enough out so that the fill may be completed to proper height for at least one track. The first point to look after in this case is the placing of the main track in its temporary location far enough to one side to be secure from interference from the new bank which will be built alongside, and which may wash down and interfere seriously with properly maintaining the main track.

It would not be extravagance to make the bank 6 ft. to 8 ft. wider than necessary for the finished bank, in order to secure this freedom from interference. It will give better drainage and the track will be much easier to maintain and safer to operate. Also the extra room on top of the new fill will be needed when the main track is constructed on the final grade. If the fill is not broad enough to carry the new main at its final elevation or the proper alinement, it must be maintained in a temporary location, and the money saved in the fill will soon

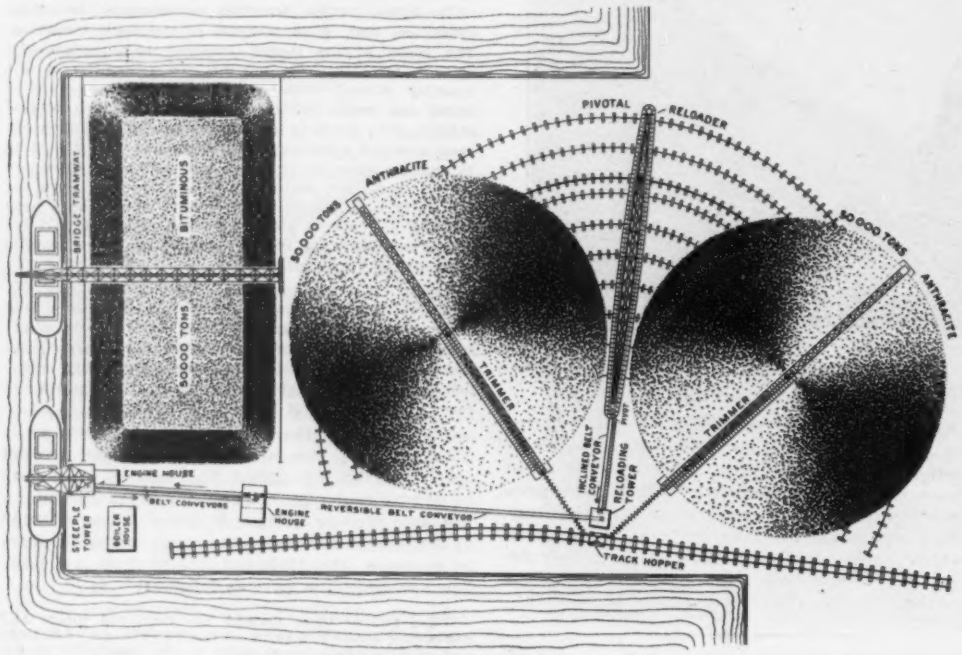


FIG. 13. GENERAL PLAN OF COMBINED ANTHRACITE AND BITUMINOUS STORAGE PLANT AT EDGEWATER, N. J.; NEW YORK EDISON CO.

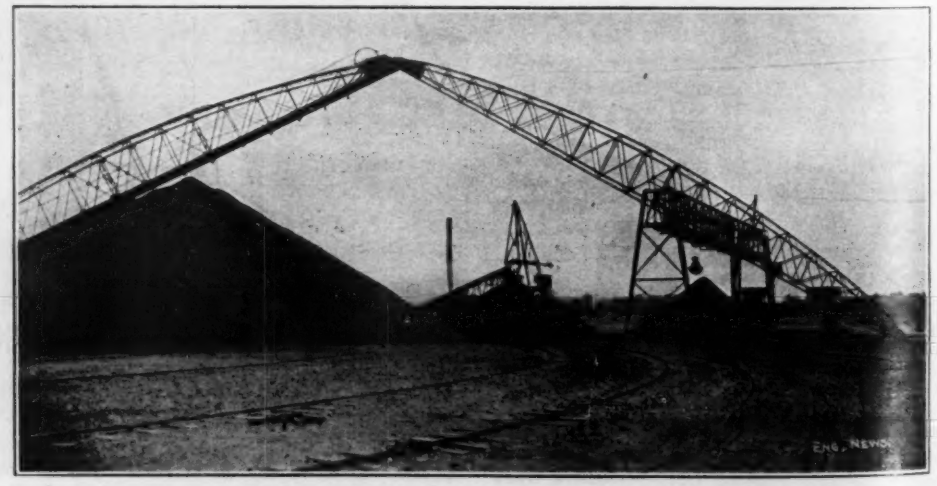


FIG. 14. GENERAL VIEW OF EDGEWATER PLANT, LOOKING TOWARD UNLOADING TOWER AND BITUMINOUS STORAGE BRIDGE TRAMWAY.

*Abstract of a paper in the "Purdue Engineering Review" for 1907; published at Purdue University, Lafayette, Ind.

†Engineer of Maintenance of Way; C., C., C. & St. L. Ry., Mt. Carmel, Ill.

disappear when the permanent main must be lined and ballasted a second time, and after much money has been put into its temporary maintenance.

The second point is to provide a proper bed of ballast. It will be found to be economy to provide a heavy bed of ballast even for temporary track as ballast means that much less labor will be required on it. Speed should be maintained at not less than 30 miles per hour and 40 is preferable. The road bed is necessarily very soft, and although the track may be easily maintained in good condition during dry weather, as soon as wet weather comes it will be found very difficult to keep it in passable condition. One derailment may serve to tie up traffic for six or eight hours with a resulting high expense, and the money had much better be applied to proper maintenance.

The third point is really most essential of all, and that is the drainage. No track, especially if on a soft bank, can be kept in fit condition for operation unless the dirt is kept from piling up above the bottom of ties. It must be kept down and water allowed to drain freely off the ballast. Although the fine dressing of permanent track should not be attempted for temporary location, an approach to the standard cross-section should be made, as this will insure sufficient drainage. A less width of roadbed than standard is permissible. In order to keep temporary track in proper condition a definite territory should be assigned to several different gangs, consisting of a foreman and ten or twelve men. Such a gang should be able to attend to all details and constantly improve conditions on about two miles of track. At times when actual surfacing and lining are not needed they may be engaged in cutting away any soil which may have washed onto track or in otherwise improving drainage, in which line there is usually plenty to do.

In cuts the expedients of temporary location for main track depend almost entirely upon the depth of new grade below the old. In case of very deep cuts, one lift may be made by the shovel clear through and at as great a depth as it will reach. By disregarding the slope the new position of main track may be secured at a distance great enough to continue it undisturbed until the cut is completed. This is a very desirable feature and should be secured if possible even at the expense of additional yardage handled. This additional yardage will probably not cost more than the ballast and labor of maintenance of the main track in a new temporary location, which amount is considerable. By figuring 10 cts. per ft. for laying track, 15 cts. per ft. for ballasting it and about 10 cts. per ft. per month for maintaining it under ordinary conditions a fair approximation may be made. This does not allow for cost of track material in spikes, bolts, broken ties and deterioration of ties from being spiked.

About 25% of value of all material except rail should be taken from total for each different position of temporary track. There is no definite assurance that you will be able to shift your main track to a different location during good weather, should you so elect to handle, and if the weather is wet or very cold weather at the time of doing the work, the cost will be much increased and the contractor will probably be delayed for a week or two awaiting completion of track. Such delays are usually at the railway's expense.

On the other hand the additional yardage necessary to handle to provide space for a location which will not be disturbed may be calculated and the expense accurately determined beforehand. The additional width of cut is a benefit to the final construction and the amount removed, which should be uniformly distributed, both in cuts and on fills, results in benefit from a broader bank.

On reconstruction work it is usually economy to have embankment exceed excavation by at least 50%, as cutting down under a track is much more expensive than raising its grade, whether under traffc or not. In shallow cuts and if final grade may be had with one lift of the shovel it appears more economical to do some broadening of the old cut by hand or with teams and to line the track as far to one side as is possible so as to clear location of new tracks. The shovel may then cut through at ultimate grade and the new main may be built behind it as nearly as may be in its final line. When the shovel finishes at the upper end a few days would suffice to put track in condition for traffic, after which the old main is removed and the shovel removes the remainder. Where this plan can be put into effect, it results in very quick and satisfactory handling and the shovel has a proper depth of cut which permits economic handling.

In all improvements of existing lines the speed and economy of construction is affected by the character of plant placed upon the work. For light work or where excavation does not average more than 50,000 or 100,000 yds. per mile, one shovel should be assigned to each 100,000 to 150,000 yds. of excavation. Contrary to most figures this will usually take the best part of one season and the work will progress at a proper speed.

The next consideration is whether to place a narrow gage outfit with 3-yd. or 4-yd. cars handled by "dinkey" or contractor's locomotive, or to use standard gage 6-yd. to 12-yd. cars handled by 40-ton or 60-ton locomotives. Either one will do well in proper hands. The advantage of large equipment is that few trips are made, making it the proper equipment for long hauls. The existing tracks may be used and this is especially useful in broadening where the embankment is light. In wet weather, heavy equipment must wait much longer than the light for the dump track to dry out so that running may be resumed. On the other hand, the standard gage outfit may be at work at once on the main track and suffer little delay. As a general thing the narrow gage will recover the soonest. Experience seems to indicate that the heavy rolling stock is the best and that it does quicker and better work in proper hands.

The method of handling track on fill is not affected by character of equipment, but in cuts it is different. On roads with heavy traffic it is out of the question to use the main track for loading track, but roads with very light or even moderate traffic not exceeding four passenger trains and six freight trains per day each way may consider this method, to which the standard gage outfit is peculiarly adapted. Delays to loading will result to the amount of three to four hours per shift of 12 hours. As the slow part of a piece of grading is usually not at the shovel, but on the dump, the time may be lost without interfering with the work. The chances for accident are great unless absolute block is maintained at each end of the track occupied and sufficiently far away to govern a safe margin for trains not fully under control.

With a narrow gage outfit the same method may be used by putting in a gantlet.

The object in each case is to save the distance necessary to allow between tracks when the loading train has an independent loading track. In any case interference, both with contractor's outfit and with regular traffic may be expected, and the only way these delays can be reduced to a minimum is to have an outfit which is in first-class condition and to establish blocks as close as possible to the shovel without crossing the danger line.

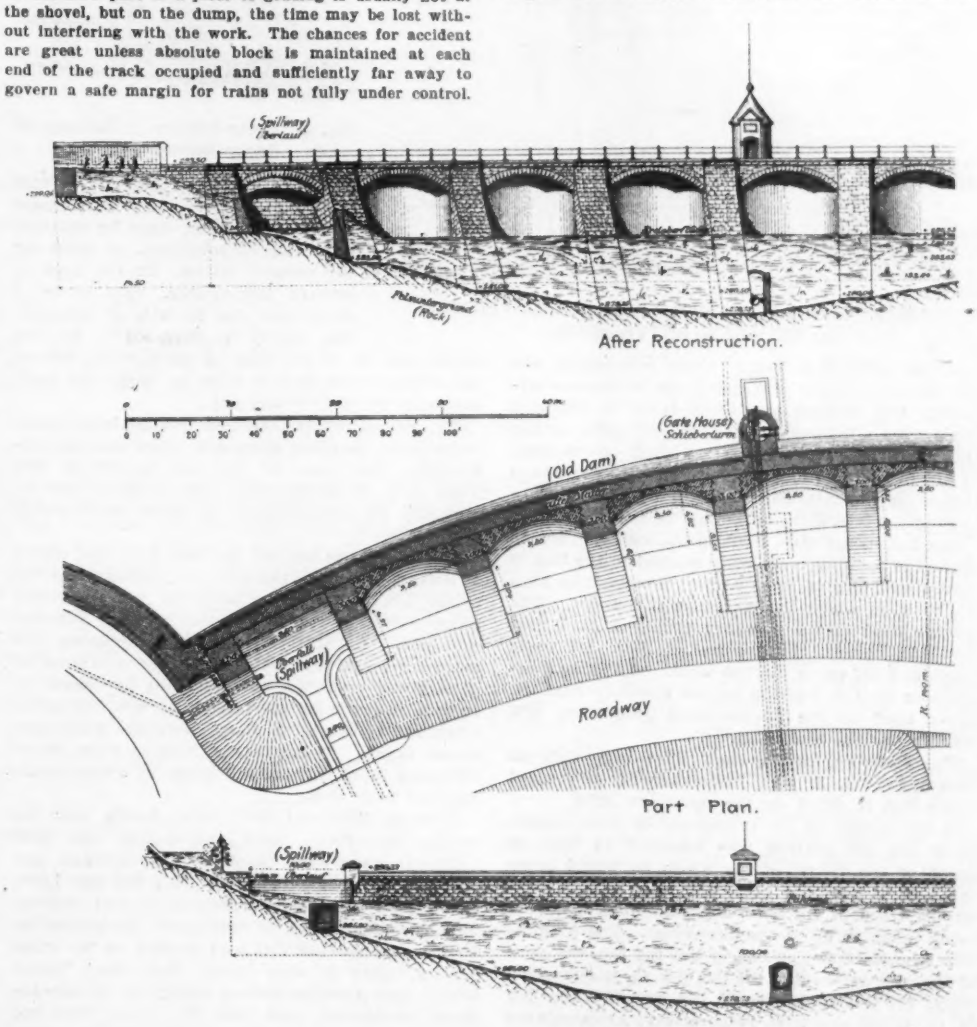
COAL MINING STATISTICS FOR INDIA are given in the annual report of the Administration on the railways of India for 1906 as follows:

	1905. Tons.	1906. Tons.
Production (mainly Bengal)	8,417,739	*9,261,714
Indian coal consumed by railways in India	2,668,424	2,878,281
Indian coal exported by sea (to Indian ports excluding Burma)	1,635,263	1,830,793
Indian coal exported by sea (to ports outside India including Burma)	1,144,680	1,394,732
Imported from United Kingdom	147,760	190,215
Imported from other countries	50,024	27,150

*Approximate.

RECONSTRUCTING A MASONRY DAM FOR INCREASED DEPTH OF STORAGE.

An unusual piece of dam-building was done recently near the city of Lennep, Germany, in connection with the water-supply system of that city. A dam for water storage had been built in 1893 in the valley of a small brook a mile and a half from the city, making a reservoir of 4¼ million cubic feet or about 32,000,000 gals. In the course of years the draft of water increased so much, chiefly because the large railway division buildings in the city were connected to the mains, that this storage was hardly sufficient, and in the dry season of 1901 the reservoir was drawn down so low that the quality of the water-supply fell off seriously. Mr. Albert Schmidt thereupon made the proposal to increase the height of the dam to give 10 ft. deeper storage, by this means more



After Reconstruction.

Part Plan.

Before Reconstruction.

FIG. 1. PLAN AND SIDE ELEVATIONS OF DAM NEAR LENNEP, GERMANY, BEFORE AND AFTER RECONSTRUCTION.

than doubling the storage, to about 10,000,000 cu. ft. This plan was adopted and carried out. The drawings in Figs. 1, 2 and 3 herewith, taken from the "Zeitschrift für Bauwesen," exhibit the scheme of reconstruction.

The old dam had a maximum height of 37.7 ft., a width at bottom of 24.6 ft. and a top width of 5.25 ft. Its length was 416 ft. In plan it was curved upstream, with a radius of about 460 ft. The foundation was on slate rock. The inner face had a double waterproofing of cement and tar, separated by a cement sheet 2 ft. thick.

The old work, which was in good condition at the time the increase of height was decided on, was used in its entirety as part of the new dam. On top of it was built a trapezoidal section 10 ft. 8 ins. high, starting with the crown width of the old dam and narrowing slightly toward the top of the new dam. The old dam was, of course, unable to take the increased thrust due to the increased height, with sufficient safety. Buttresses were therefore carried up on the downstream face

of the dam for the purpose of taking the added thrust on the lower section and the entire thrust on the top section. These buttresses are spaced 41 ft. apart on centers, and have a uniform thickness of 9.84 ft. At the section of maximum height the toe of the buttress extends 26.24 ft. downstream from the toe of the old section (Fig. 2), while at the level of the crown of the old dam the width of the buttress is 10.66 ft. To ensure the transmission of the weight of the top section of the dam to the buttresses, a series of arches is sprung between the buttress at the crown level.

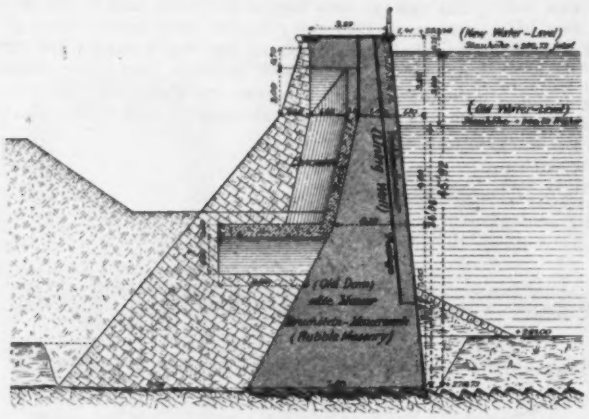


FIG. 2. CROSS-SECTION OF RECONSTRUCTED DAM BETWEEN BUTTRESSES.

Another series of arches, at about mid-height, has the purpose mainly of bracing the buttresses laterally and making the whole body of masonry more rigid. Between the upper and lower arches there is in each case a vertical arch of concrete, to aid in transmitting to the buttresses the added thrust on the intermediate portions (rather than relying on lateral beam-action in the dam).

The buttresses were built in inclined courses, to make the bedding practically normal to the line of thrust and to give more perfect interlocking with the rock on which the structure is founded. The mortar used in the masonry consisted of 1 part Portland cement, 1 part slaked lime, 1½ parts trass, and 4½ parts washed sand. The same mortar was used in making up the concrete mixture, being used in the approximate proportion 45% mortar to 55% broken stone.

The spillway for the new dam was built as shown in Fig. 3. An icebreaker of galvanized angle-iron is fitted on the upstream side.

In the design of the reconstructed dam, apparently the old portion was assumed to take so much of the thrust of the water as would bring the line of pressure near the outer edge of the middle third of its base, the remaining pressure being taken to go to the buttresses. The foundation pressures are stated to be: for the old part, 43 lbs. per sq. in. and 2.1 lbs. per sq. in., respectively; for the buttresses 55 lbs. and 28.5 lbs. per sq. in. at toe and heel, respectively; as calculated by an approximate method. The curved shape of the dam was not considered in the calculations, and its arch action represents an added margin of safety.

SOME COST FIGURES ON FOREST PLANTING FOR RAILROAD PURPOSES.

By E. A. STERLING.*

The advisability of forest planting on waste lands in the East is coming to be more generally realized, and is a question deserving vigorous and systematic action by landowners, particularly large corporations owning extensive tracts of unproductive land. Forest planting is a policy which promises to give good returns, either to private landowners as an investment and legacy for their heirs, or to long-lived corporations, which will still be doing business when the trees mature. It is, moreover, a matter deserving consideration on patriotic and economic grounds, for there is nothing which will contribute more to the material prosperity of a commonwealth than to have its waste lands utilized for the production of timber crops and as a protection against erosion and destructive floods.

Attention has been forced to these things in late years by the increasing prices of lumber and the scarcity of the better grades, by government statistics which show that an increasing and extravagant consumption of wood is maintained in the face of a rapidly decreasing supply, and by the destructive floods in many of our large rivers, particularly in the vicinity of Pittsburg and along the Ohio River, due largely to the removal of the forest cover on the headwaters of these streams. Despite all of this evidence, comparatively little forest planting has been done by individuals and corporations, or even by the several states. In the case of private landowners, this is in a large part due to lack of information as to the methods to be followed and as to the cost of such work, for on the original cost figures must be based the estimates on whether it will pay.

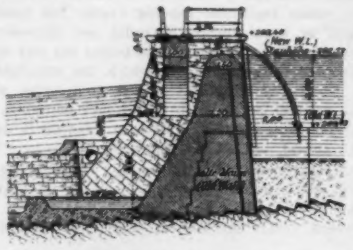


Fig. 3. Cross-Section of Spillway of Reconstructed Dam.

The Pennsylvania Railroad has probably done more forest planting than any other eastern corporation, and some of the cost figures on this work may be interesting, and possibly give an incentive for similar work by other land-owning companies.

The work was started in 1902 with the object of determining the feasibility of utilizing, for the production of timber suitable for cross-ties and fence posts, land acquired and held for railroad purposes. In straightening and widening the main line, and to avoid expensive overhead or undergrade crossings and damages by reason of stream or drainage interference on new low-grade lines, the company in many instances purchased entire farms. These farms, ranging from 20 to 200 acres in extent, are the lands on which planting has been done.

Between 1902 and 1907 black locust was the species exclusively used, and during this time 1,679,320 trees were planted. The average cost of planting was a little less than $20 per 1,000, but as the work was experimental and entirely new this cost cannot be considered representative. In the spring of 1907 it was decided to try other species, since it was found that the "locust borer" was working serious injury in the plantations established, and that the locust was not adapted to all the situations available for planting.

The following table shows the various species and the total number of trees planted in the spring of 1907, with average cost figures:

Species.	No. of seedlings planted.
Red oak	252,154
Black locust	175,716
European larch	6,970
Pin oak	4,570
Scotch pine	3,500
Tamarack	3,000
Chestnut	2,316
Total	448,226

The average cost of actually planting these seedlings was $6.04 per thousand, while the total cost, including the price paid for the seedlings, was $11.29 per thousand, or $15.93 per acre.

The 448,226 trees listed above were planted during April and May at three points on the main line between Harrisburg and Altoona, on ten typical farms which were acquired for railroad purposes. The cost items represent, with a fair amount of accuracy, the expense of private planting on such scattered areas and under existing labor conditions. At Altoona, where Italian laborers were employed and the trees planted 6 × 6 ft. apart in small holes prepared with a mattock, the cost was $5.12 per 1,000. This cost increased to a maximum of $7.85 at Mt. Union, where American labor was used and the trees were set 4 to 6 ft. apart in furrows plowed 5 ft. apart; while at Newton Hamilton, where the same crew planted in furrows, the cost dropped to an average of $4.82 per 1,000, the expense of furrowing being included in both cases. The difference in cost was due largely to extra expense at Mt. Union in clearing the ground from brush, and in resetting fences. Marked variations in the cost of planting may always be expected, but the average of $6.04 per 1,000 may be considered a fair approximation of the expense for reforesting old fields where there is not much brush to hinder operations.

The seedlings planted ranged from one to three years old, and were purchased from commercial nurseries at an average cost of $5.25 per 1,000, making the total cost $11.29 per 1,000. With the usual spacing of 6 × 6 ft., or 1,210 trees to the acre, the cost of such work per acre would be about $15. The Pennsylvania Railroad has established a large forest nursery at Hollidaysburg, near Altoona, in order to grow its own plant material. With home-grown seedlings, the total cost of establishing forest plantations should not exceed $10 or $12 per acre, if the work is done on a large scale.

In the choice of species, much depends on the character of the ground and on the use which is to be made of the timber when mature. A railroad company is naturally most interested in cross-ties and fence posts, and the fastest growing timber suitable for these purposes would be selected. The most desirable trees, however, are often of discouragingly slow growth, which necessitates a compromise between growth and quality; for example, red oak is being planted instead of the more durable white oak, because of its faster growth, and on the assumption that treatment with preservatives will be in general use by the time the trees mature. Scotch pine is being used with the same end in view. In the light of European experience, both red oak and Scotch pine woods, if creosoted, and protected from mechanical abrasion under the rail, will have double the life of untreated white oak. Such species as pin oak and tamarack are used in wet situations, where the more valuable trees would not flourish.

*Forester, Pennsylvania Railroad, Broad Street Station, Philadelphia, Pa.

TWO-STAGE OPERATION OF A LARGE PUMPING ENGINE.

By A. O. DOANE.*

In consequence of the increasing consumption of water in the district supplied by the Southern high-service pumping station of the Metropolitan Water-Works of Massachusetts, it became necessary to provide additional reserve pumping machinery. To do this in the ordinary way would have necessitated an enlargement of the station building at great expense. This would have involved paying interest and other fixed charges on the enlargement as well as on a costly pumping engine which would rarely be used except in case of emergency.

These considerations led to the adoption of the plan proposed by Mr. F. P. Stearns, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Water and Sewerage Board, to make such changes in one of the engines in the adjoining low-service pumping station as would enable it to be used in pumping to high-service as well as to low.

The conditions at the low-service station are unusual. In consequence of the putting in service of the new Weston Aqueduct, through which water can be supplied to the low-service district by gravity, a considerable reduction has already been made in the quantity to be pumped, and with the construction of additional gravity supply pipe lines the pumpage will be still further reduced.

The pumping equipment at the low-service station consists of three 35,000,000-gal. triple expansion vertical pumping engines, built by the Holly Manufacturing Co. Each engine has two discharge and two suction pipes. The discharge pipes of all the engines connect at the rear with a 36-in. equalizer pipe (see Fig. 1) which is con-

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nected to a large steel plate tank open at the top and fitted with an overflow pipe leading to the suction well. When the pumps are in operation, the water is backed up in this tank to a height equivalent to the pressure in the discharge pipes. The front ends of the discharge pipes are connected to two 48-in. distribution mains which extend across the Metropolitan District, a distance of about 12 miles, to Spot Pond. This pond is used as a low-service distributing reservoir and has a capacity of 1,792,000,000 gals. The water stored in this pond furnishes a very large reserve supply, which can be drawn on at any time in case of accident to the pumping machinery or other emergency. The suction pipes of the several pumping engines are connected to separate wells, which are supplied through sluice gates from a conduit which connects with Chestnut Hill Reservoir near by. The elevation of the water in the pump wells is ordinarily about 6 ft. above the suction valves, so that the water flows to the pump under a small head.

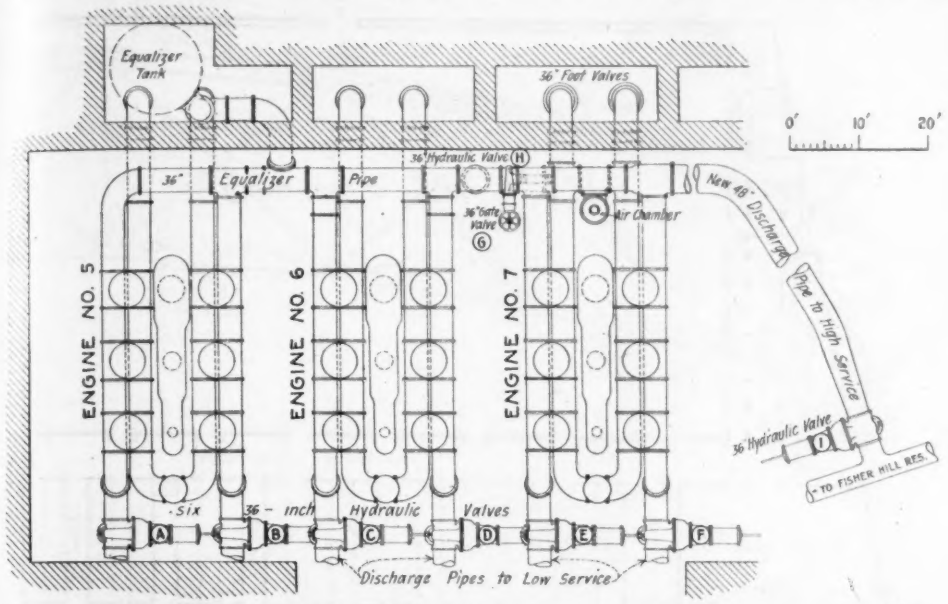

FIG. 1. ARRANGEMENT OF ENGINES AND PIPING AT THE LOW SERVICE PUMPING STATION, CHESTNUT HILL RESERVOIR, METROPOLITAN WATER AND SEWERAGE BOARD.

This comparison of lifts suggested the idea that the two-stage method of operation, quite commonly used in centrifugal pumps, might be applied to the case, in view of the fact that most of the time two pumps were more than sufficient to take care of the low-service consumption and part of the time only one was required.

Plans were accordingly prepared for the necessary changes in piping and Engine No. 7 was selected as the one most favorably situated for the proposed work. A 48-in. connection, controlled by hydraulic valve I (Fig. 1), was made between the discharge pipe of this pump and a 36-in. high-service main, in the grounds just outside of the pumping station, which in turn was connected with the system of mains which extends to and discharges into Fisher Hill Reservoir. A 36-in Coffin foot valve was put on the end of each of the suction pipes in the pump well. The flaps of these valves can be fastened back when pumping to low-service. A 36-in. connection, controlled by the hydraulic valve H, was made between the equalizer pipe and the suction pipes of No. 7 engine, and a 36-in. valve (G) was set in the equalizer pipe between engines Nos. 6 and 7.

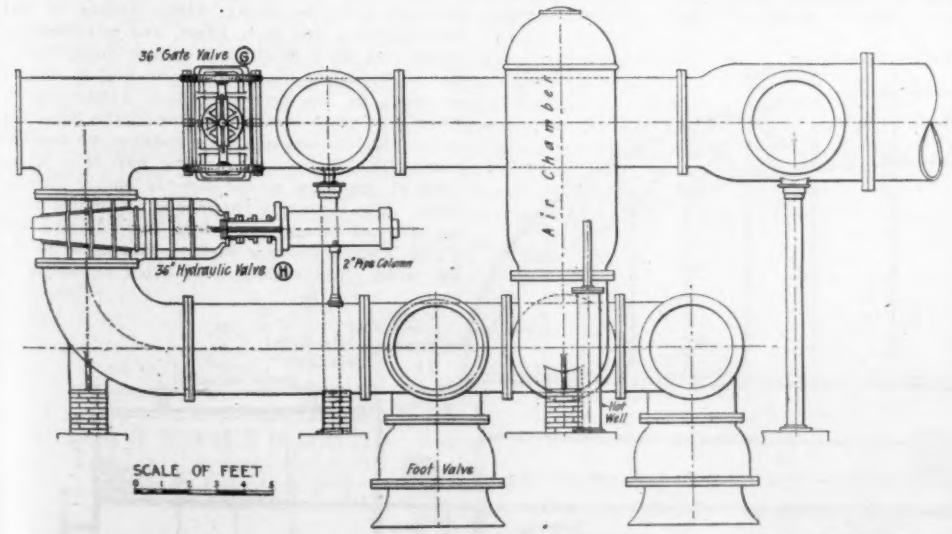

FIG. 2. ELEVATION SHOWING CHANGES IN PIPING OF ENGINE NO. 7, LOW SERVICE PUMPING STATION, CHESTNUT HILL RESERVOIR.

In studying the subject of the reserve pump, it was found that the maximum lift against which the pumps had been operated on the Spot Pond or low-service was about the same as the difference between the maximum elevation of the water in the discharge pipe equalizer tank and the elevation of high water in Fisher Hill Reservoir, which has a capacity of 16,000,000 gals, and is the equalizing and distributing reservoir for the Southern high service district.

By closing valve G and opening valve H, the water from the discharge pipes of the other two pumps, which are connected to the equalizer pipe, is brought into the suction pipes of No. 7 pump, under any desired pressure, up to the limit of the equalizer tank overflow. The foot valves on the suction pipes prevent the water from running back into the pump well and the 36-in. valve G being closed prevents the water in the discharge pipe, when under high-service pressure, from running back into the equalizer pipe. The hydraulic lift valves E and F on the discharge pipes of No. 7, connecting to the low-service mains, are closed when pumping to high-service, and the water pumped by No. 7 flows through the new 48-in. discharge pipe and Valve I to the Fisher Hill mains.

Cast lead weights were placed in the hollow plungers of No. 7 pump in order to equalize the strains in the crank shaft caused by the higher pressures in the suction and discharge pipes. As a matter of extra precaution, special supports were placed under the valve decks, although calculation showed that they were probably strong enough to bear the increased load unsupported.

When Engine 7 is pumping to high-service, the hydraulic lift low-service discharge gates A and C on engines 5 and 6 are closed and B and D partly closed, thus backing the water up in the equalizer tank and decreasing the total lift of Engine 7 by increasing the suction pressure. The work of the other two engines is, of course, somewhat increased by this arrangement and all water pumped in No. 7 must have been previously pumped by the other engines and is thus diverted from the low-service supply.

Of course, this is an uneconomical method of operation and would not be considered at all if it was to be used frequently or for long runs, but it is only intended for use in case of extraordinary emergency, as there is still reserve capacity at the high-service station sufficient to provide for ordinary contingencies. The principal object in view in adopting this method of pumping is to put off as long as possible the installation of another large pumping engine at the high-service station, and thus save the interest and other fixed charges on the costly machinery and addition to the building. The total cost of making the changes in piping both inside and outside of the low-service pumping station and alterations of the machinery was $13,500, the annual charge on which would be $540, while the estimated annual charges on the installation at the high-service station would be about $8,000, a difference of $7,460, certainly worth saving. Another advantage is that when it finally becomes necessary to put in another high-service pumping engine, it will be possible to install a plant embodying all the improvements which may have been made in this class of machinery.

When Engine 7 was tried on high-service work it ran smoothly and well, no trouble of any kind developing. When the circumstances under which it operates are considered, there seems to be no reason to doubt that the expected advantages to be gained by making the changes in Engine 7 will be realized.

THE ERIE CANAL ARCH BREAK AT SYRACUSE, N. Y., is being repaired rather more slowly than had been expected. The pile-driving for the new abutment foundations is proving troublesome on account of old timber-work in the ground. At the present writing it seems unlikely that repairs will be so far advanced that traffic in the canal can be re-established before the middle or end of September. Excavations under those parts of the partly-wrecked arch which still remain standing show that the masonry abutments and piers of the three arches rest on a sort of pile and grillage foundation. Along each pier or abutment there were three or four rows of short piles, say 10 ft., spaced perhaps 2 ft. apart in each row. Transverse to the arch and the abutment, 12 x 12-in. tie-timbers or sills extended from the piles of one pier to those of the opposite one, lying over a pile of each row and thus forming caps for the transverse pile-bents, so to say. Over these sills a decking of 6 x 12-in. timbers was laid, at the pier or abutment, these deck-timbers running longitudinal to the pier. The pier masonry rested on this decking. As will be recalled from our description of the break (Eng. News, Aug. 8, 1907), the failure affected an intermediate section of the west arch of the three, embracing something more than one-third in length of the west abutment; but both ends of the arch-barrel and its abutments remained intact. Where this section of abutment wall went out, the timber decking below the masonry appears to have been sheared off at either end of the gap where the abutment went out, and the piles below this portion were greatly displaced, either torn out or laid over into the soil of the foundation.

A LONG-SPAN TRUSS ROOF: ARMORY FOR SQUADRON C, NEW YORK NATIONAL GUARD, NEW YORK CITY.

An armory recently completed in Brooklyn, New York City, for the use of Squadron C, N. Y. N. G., represents carefully studied design in several features, notably in the utilization of space for the required purposes and in the design of steel framing in the main portion of the building, the large riding-hall. The general characteristics of the structure and of the steel riding-hall roof are shown in the accompanying series of drawings and are briefly summarized below.

The ground area available for this armory represents an individual block 255 ft. 7 ins. by 382 ft. maximum length, slightly trapezoidal in shape. The structure to be erected thereon was required to furnish quarters for two cavalry troops of the militia, including stables for the horses, assembly rooms for the men, administration rooms, etc., and in addition a riding-hall of as large a size as practicable. Plans for the structure were called for by the New York State Armory Board in open competition. The successful plans were those submitted by Messrs. Pilcher & Tachau, of New York City, and these plans, with minor modifications, were executed.

Fig. 1, which is a ground plan of the main floor of the armory, together with Fig. 2, an end view part section and part elevation, exhibits the principal features of the layout of the building. The drill hall occupies the main portion of the plot, having a clear floor space of 175 by 310 ft. The floor of this hall is directly on the surface of the ground, there being no basement below. An arched roof, with monitor, covers the hall. The lighting is mainly from the gable ends, an innovation which required an end-wall construction practically identical with that of train-sheds.

South of the drill hall a corridor, the mounting corridor, extends along its length, separating the riding hall from the stables, which latter are thus provided for close to and on the same floor as the riding hall. An arrangement of the stables in separate pavilions is secured by cutting deep bays in from the exterior, so that outside light is secured for each separate stall. Access to all stables is from the mounting corridor, which, in turn, is reached from the outside by a passage, near the east end of the corridor, leading to an inclined runway on the south side of the building.

The narrow strip lying to the west of the riding hall and the entire southwest corner of the building, are utilized for assembly and administration rooms. Two large squad rooms, one above the other, the lower one two stories and the upper only one story in height, with ceilings furred into a vaulted form, occupy the southwest corner. Between the squad rooms and the stables lie: On the lower floor a saddle room and on the upper floors sergeants' rooms, janitor's quarters and the like. The narrow west end or front of the building contains the main entrance and corridors and all requisite administration rooms and rooms for minor purposes. This portion of the building is two stories in height and extends no higher than the beginning of the curve of the drill hall roof, thus leaving the entire segmental surface of the drill hall gable clear for end lighting. The portion containing the squad rooms is three stories in height, and at the extreme front of the building, in line with the mounting corridor, it is surmounted by a tower, six stories in total height. The tower is mainly ornamental in purpose.

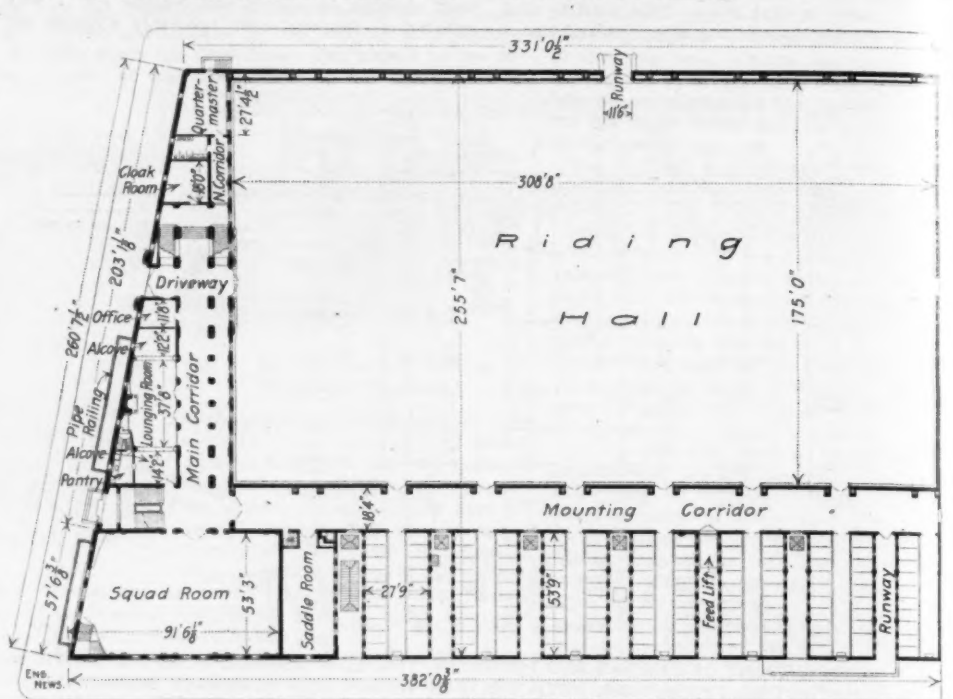

FIG. 1. PLAN OF MAIN FLOOR, ARMORY FOR SQUADRON C, N. Y. N. G., NEW YORK CITY.

The portion of the building containing the stables is but one story in height, counting from the drill-hall floor. However, there is a basement under the stables, of full clear height above the ground, affording space for boilers, swimming pool, shower baths, etc., and a large storage room. The space lying under the mounting corridor is utilized as a shooting gallery, two ranges being provided, respectively for rifle and for revolver practice.

A powder magazine is arranged in the solid ground under the riding-hall floor, lying at the extreme southeastern corner of the hall. It is built as a vaulted chamber of solid concrete, approached by a passage (also in solid concrete) below the floor of the shooting gallery and connected by a flight of steps with the storeroom under the stables. The magazine chamber has a ventilating duct leading to a flue located in the east wall of the building.

Structurally, the armory is of steel skeleton type, with brick walls and concrete or reinforced concrete floor arches and slabs. The administration and stable portions of the building, that is, everything except the great riding hall, is framed of columns and beams in the usual manner, and offers nothing of special note except the use of the Gray type of column throughout. The riding hall is covered by an arched roof construction of steel trusses and purlins.

The floors in the building are in general of reinforced concrete, being either arches or flat slabs between the steel joists, and reinforced in either case with Wight lock-woven metal fabric. The surfacing of the floors is wood (1-in. spruce or pine) in the corridors and administration rooms and plain cement flooring in the basement rooms (12 ins. concrete on a cobblestone foundation). The floor of the riding hall is a 12-in. layer of tan bark placed directly on the natural earth. The mounting corridor has a double flooring of wood, comprising a 2-in. underflooring and a 2-in. spruce wearing surface, laid in strips 2¼ ins. wide. The stables have brick pavement in

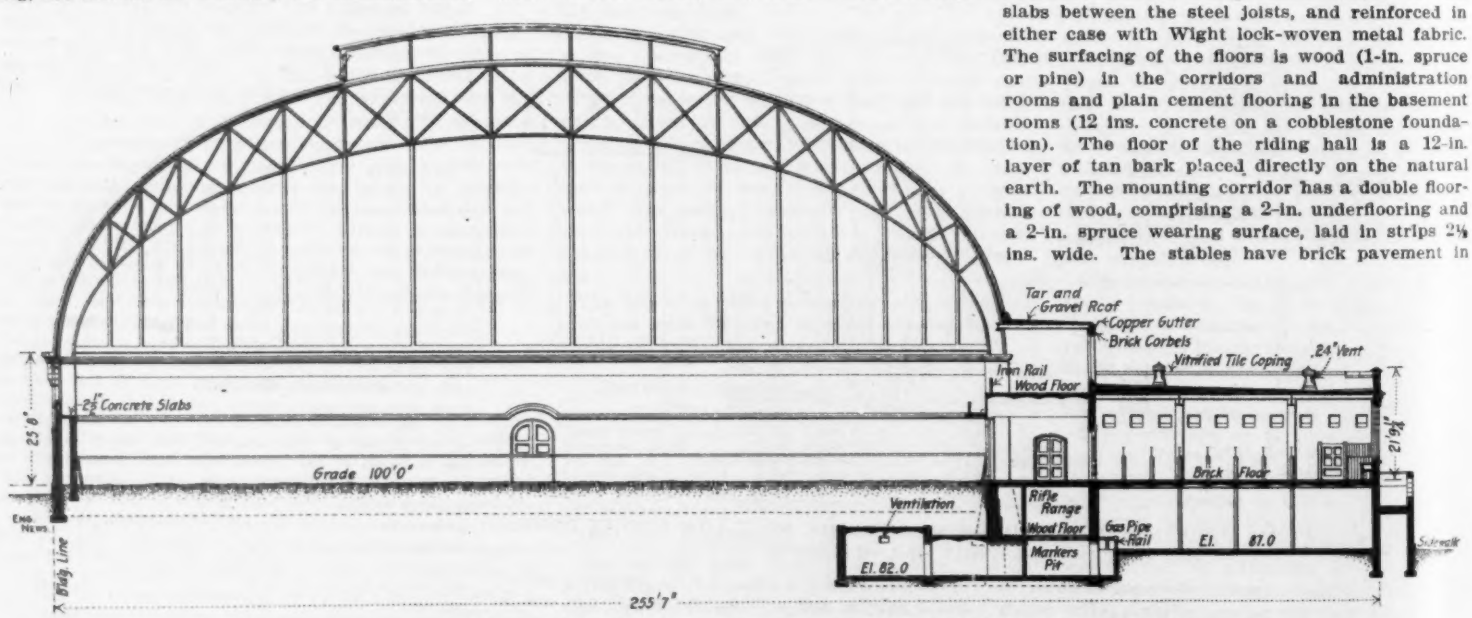

FIG. 2. CROSS-SECTION THROUGH RIDING-HALL AND STABLES, ARMORY FOR SQUADRON C.

the gangways between the opposite (back-to-back) rows of stalls, and in the stalls a single thickness of spruce flooring on the concrete.

The roof surfaces, except that of the riding hall, are carried by a reinforced-concrete flat slab construction similar to that of the floors and are covered with tar and gravel. The riding

hall roof surface is composed of separately-molded slabs of reinforced concrete, 2½ ins. thick, each slab 2 × 5 ft. in size. An asphalt and fabric roofing material (Star roofing) is laid over the concrete as weather surface.

The walls of the building are of brick, with limestone trimmings in the lower story and terra cotta trimmings above. In the riding hall, where the wide column-like portions of the roof trusses are in the line of the north and south walls, the brickwork is carried around them to form a complete enclosure, which, however, is kept clear of the steelwork so as to allow full freedom of expansion and contraction of the roof structure. The east and north walls of the riding hall, which are external walls of the building, are double, with an insulating air space between the inner and outer brick wall. In the east wall this air space is 2 ins. wide, while in the north wall it is made 30 ins. wide so as to give the wall sufficient thickness to enclose the legs of the roof trusses without projections on either side of the wall. In the case of the south wall, a flush inner surface of the wall was readily obtained by placing the truss legs so as to project into the mounting corridor.

RIDING-HALL ROOF.

The general outline of the riding-hall roof, as shown in Figs. 2, 3 and 5, gives the governing conditions for the steel framework required to support that roof. The outline of the roof was, of course, determined by architectural considerations exclusively. A further condition set by the architects was that the steel framing should encroach as little as possible upon the clear floor space of the hall for a distance of 15 or 20 ft. above the floor. This meant that the end sections of the trusses should be vertical and as narrow in width as possible. If an arch, either two-hinged or three-hinged, were used, these end sections would necessarily have heavy bending moments. By employing a truss, on the other hand, the bending moment in the end portions is reduced to a minimum, while the moments in the middle part of the truss, where the requisite depth of frame is readily provided for, are increased. This latter arrangement evidently promised greater economy in the present case, and was therefore adopted by the engineers for the structure, J. H. Gray & Co., of New York City. The trusses, while of arched form, are simple trusses, being fitted with a roller bearing under the north shoe to make the reactions vertical.

With the general style of supporting frame decided upon, there were only minor complicating conditions to be considered. Of these, the lighting by a full glass surface in the gable ends in place of roof lighting has been referred to. The connection of the riding-hall frame with the framework of the stable portion to the south caused but slight complication; a balcony here made it impossible to continue the wind bracing to the floor level and hence necessitated portals at some height above the ground (Fig. 4). Above the mounting corridor a gallery for spectators is disposed and this required to be bracketed out over the riding-hall floor. The construction adopted employs deep girders anchored in the south wall of the corridor and cantilevered out over supports on the main trusses of the riding-hall. The top flanges of these girders are stepped to suit the stepped floor surface of the balcony. The latter also extends along the west line of the riding hall from the corridor in the administration part of the building. The exact disposition of the horizontal wind truss at this end of the building was dependent upon the arrangement of this balcony.

The adoption of trusses, with one end supported on rollers, meant that considerable lateral movement in the framework would have to be provided for. This affected the connection between the west gable and the roof over the administration building, and the connection of the trusses with the north wall of the riding hall.

The riding-hall roof truss is shown in Fig. 3. The general arrangement of the roof is clearly shown in the framing plan (Fig. 4), which exhibits the relative location of trusses, purlins, jackrafters and wind bracing. The trusses are arranged in pairs forming braced towers, following the construction so common in trainsheds. In the north wall the bracing of these pairs extends quite to the base, but at the south wall, on account of the location of the balcony already mentioned, a portal construction replaces the wind diagonals in the vertical part of the trusses. The subsidiary roof framing comprises lattice-girder purlins which frame into the trusses and I-beam jack-rafters spaced about 5 ft. 7 ins. apart. The concrete roofing slabs are long enough to just span this distance, making a butt-joint in the vertical plane of the jack-rafter.

It should be said that the purlins are in general in a vertical plane, except that the three purlins immediately above the eave strut are set radial to the roof. Small subsidiary brace frames, intermediate between the main trusses, hold the flanges of these radial purlins from sagging; the eave strut is a lattice-girder in the vertical plane, and the subsidiary brace frames in question bear upon this strut. For connecting

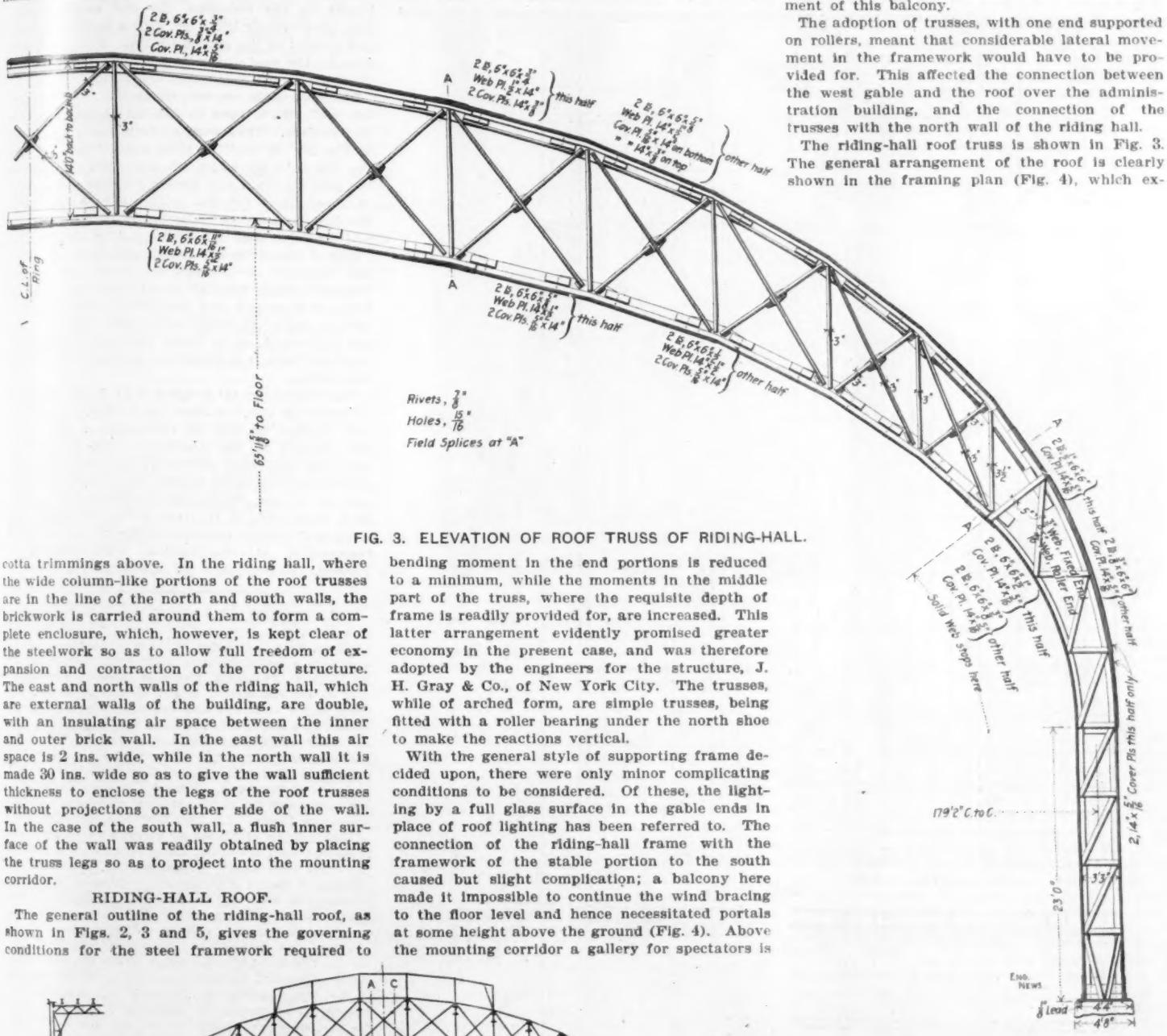

FIG. 3. ELEVATION OF ROOF TRUSS OF RIDING-HALL.

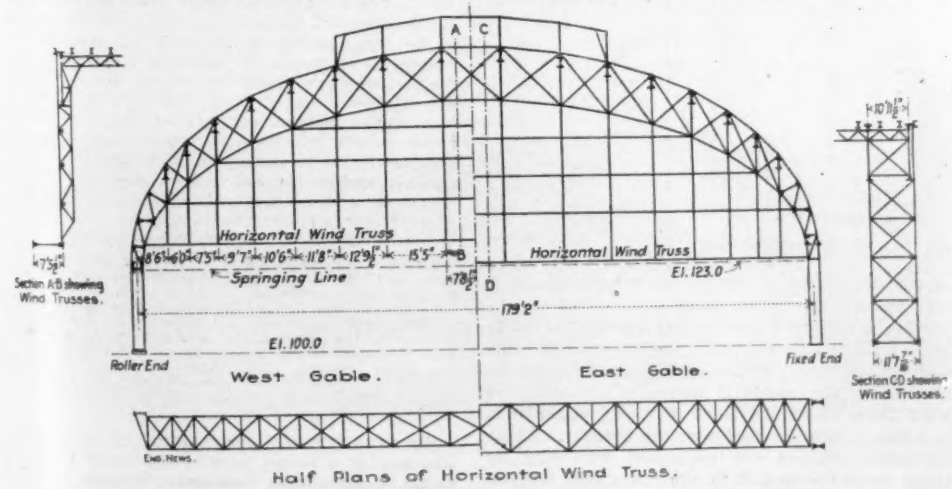

FIG. 5. WIND TRUSSES AND BRACING AT GABLE ENDS OF RIDING-HALL.

the jack-rafters to the purlins it was proposed at first to extend the gusset plates of the purlins above the top flanges, and frame the jack-rafters into these gusset plates. The contractor, however, preferred to use a small bent plate packing block on the top flange of the purlin to support the jack-rafter, the butting ends of the jack-rafters being cut at an angle and joined by a web-splice.

Fig. 8 shows a detail of the end sections of the trusses. It represents typically the character of the work throughout this roof, and in particular shows the details adopted at the fixed and roller end supports of the trusses. A heavier flange section is used at the fixed end than at the roller end, because of wind effects concentrated in the fixed-end half of the truss and because the portal bracing at the fixed end increases the extreme fiber stresses in the flanges.

Where the legs of the trusses extend down through the hollow interior of the north wall, the brickwork is kept clear of the steel at all points. The pier footing of each truss is independent of the wall footing, and extends beyond the wall both inside and outside. The wall footing is, therefore, interrupted at each pier; on the inside the wall is carried across the pier by an arch just below the ground surface, while on the outside a small I-beam spans the opening, and a thin brick curtain wall closes off the space between this beam and the lower courses of the truss pier.

The arrangement of bracing at the gable ends is indicated by Fig. 5. A horizontal wind truss extends across each gable near the beginning of the curve of the roof. The ends of each wind truss abut against the main trusses at the level of the eave strut, to which the wind pressure is transferred. A sliding joint is provided at the northerly connection, to permit the roof truss to move on its roller bed under the influence of loads and temperature. At the west gable the presence of the balcony made it necessary to raise the wind truss above the level of the springing line, to bring it into the roof over the balcony. These horizontal trusses are supported vertically by truss frames attached to the main roof trusses. At the east end these frames carry the wind pressure directly into the cross-frames of the roof-truss tower. At the west end, however, there is no tower but only a single roof-truss, so that the vertical frames had to be carried up to the lateral bracing in the roof plane. The vertical stiffening frames carry girts to which the copper framing for the glass is directly attached.

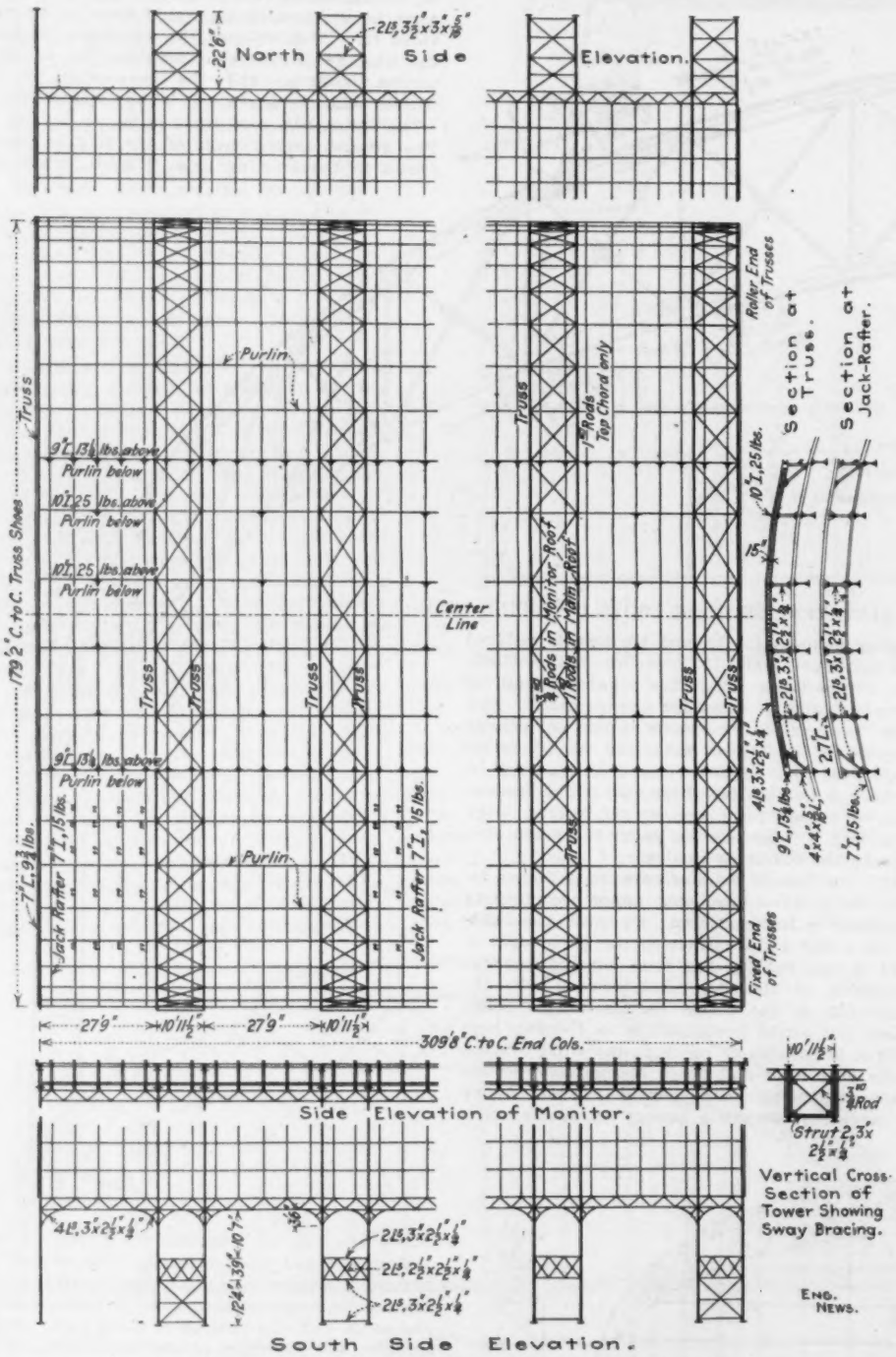

FIG. 4. PART FRAMING PLAN OF ROOF OF RIDING-HALL.

The roof trusses were built in three sections, as indicated in Fig. 3, so that only four joints in each truss are required to be made in the field. Two timber travelers were used for erecting the roof, as shown in the view Fig. 7. The middle section of a truss being lifted up and set on blocks on the travelers, the end sections were then successively lifted up, set on their end shoes and riveted to the middle section. This work was done by the steel contractors, the Fort Pitt Bridge Works.

The roof slabs on the riding-hall roof are reinforced with a layer of wire fabric near the bottom surface. They were made in forms as shown in Fig. 10. In molding them holes were cored for the clip bolts by which the slabs are attached to the roof framing, and square recesses at the tops of these holes for the nuts. Fig. 9 illustrates the fastening of the slabs to the jack-rafters. It will be seen that the horizontal or longitudinal joints of the slabs are tongue-and-grooved, while the vertical or transverse joints are simply butted. These vertical joints come over the I-beam jack-rafters, and were filled with asphaltic cement after the slabs were laid. These joints are not relied on to make the roof tight, however, as there is a surfacing of Star roofing over the slabs.

The Squadron C Armory was built by John Kennedy & Son, of New York City. The Fort Pitt Bridge Works, of Canonsburg, Pa., built and erected all the steelwork. The fireproofing and floor and roof concrete, including the reinforced-concrete slabs on the riding-hall roof, was put in by the Wight-Easton-Townsend Co., of New York City. J. H. Gray & Co. were the engineers and in this capacity designed all the steel framework, in consultation with Pilcher & Tachau, the architects for the structure.

THE FINANCES OF BOSTON are to be investigated in a broad way, involving engineering as well as other problems, by a commission of seven members, in accordance with a recommendation made some months ago by Mr. John F. Fitzgerald, Mayor of Boston. The Chairman of the Commission is Mr. Nathan Matthews, formerly mayor of Boston and well-known by some of our readers as a lawyer who has taken a leading part in various water-works litigations during the past few years. The members of the committee represent various local interests, having been nominated by such bodies as the Chamber of Commerce, Railroad Exchange, Central Labor Union, and the various citizens' associations of Boston, acting jointly. The Boston Finance Commission has an appropriation of $50,000 for carrying on its work, and is allowed until December, 1908, to make its report. It has called upon Messrs. Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, to advise it in matters pertaining to water and sewerage and possibly other subjects, and will probably employ other engineers to assist it in considering such subjects as street pavement and cleaning, and garbage and refuse collection and disposal. The broad general duties of the commission are to "examine into all matters pertaining to the finances of the city, including debt, taxation and expenditures." Among the subjects to be considered by the commission are the following: Whether or not the city expenditures are at present properly divided between those met by loan and by taxation, and whether city loans are for proper periods; whether debt, taxation and assessments on property are excessive, and, if so, how they can be reduced; bookkeeping and auditing questions; whether the system of assessments for benefits should be extended; whether [any of] the several departments of the city have larger appropriations than necessary; and

Whether it is advisable to create new sources of revenue, and, if so, to suggest the sources and for what purpose the proceeds should be applied.

To inquire into the present general plan of sewer construction and report whether or not it is the one best adapted to the city, and, if not, to investigate and report a comprehensive scheme for future development of the sewer system, with special reference as to the amount of money the city can annually afford to spend for the completion of work already begun.

THE DENSITY OF POPULATION IN AUSTRALIA, according to a census bulletin just issued by G. H. Knibbs, Commonwealth Statistician, increased from 1.27 to 1.38 in the six years from 1901 to 1906. The population densities in the other continents, according to the report are as follows: Europe, 100; Asia, 49; Africa, 15, and America, 9.

GAS LIGHTING FROM A HYGIENIC VIEWPOINT.

A lecture by Professor Vivian B. Lewes, F. I. C., F. C. S., at the June meeting of the British Institution of Gas Engineers, arraigns the long-believed hygienic value of electric lighting. Following are several excerpts from the address:

The effect of burning coal gas as an illuminant on the air of our dwelling rooms and the health of its occupants is as old a subject as the use of coal gas itself; and in the early days of the gas industry it threatened to wreck its future for indoor illumination, as the crude gas then sent out, rich in sulphuretted hydrogen, gave rise to such discomfort when consumed, that ventilating burners of clumsy device had to be employed for its use, while badly made and leaky fittings gave at all times an aroma which suggested to the nose and mind of the householder a doubt as to the sanitary condition of the drainage.

A very short period, however, served to convince the gas manager that the purity of the gas was a matter of even greater importance to him than to the public, as the latter could escape the effects of the sulphurized products of combustion by adopting other illuminants; while the gas manager's livelihood depended on keeping his customers. As a result, purification from sulphuretted hydrogen was adopted, and the use of coal gas increased with enormous rapidity.

With the advent of the electric light as an illuminant, great stress was laid upon its enormous advantages from the hygienic point of view; and its supporters still make the claim that it must of necessity be far more healthful to use as an illuminant than coal gas. It has not unnaturally been assumed that, owing to incandescent electric lighting adding nothing to the impurities in the atmosphere, and—what is quite as important—withdrawing no oxygen from it, it must be the most hygienic form of illumination to employ; but in the years which have elapsed since electricity was pressed into the service of man for illuminating purposes, it has become perfectly clear that, though it is inactive as regards vitation of the atmosphere, *a gas lighted room will nearly always be more pleasant and healthy to live in than one lighted by the newer form of illuminant.*

I have in my mind at the moment a hall, which in the old days was lighted by gas, and in which a large audience could with comfort sit through an hour's lecture or with pleasure through a three hour's dinner, but which, with the march of civilization, had its illumination changed from gas to electricity; the latter being employed with all the latest refinements to effect the lighting under the best conditions, with the result that any large gathering within its walls leads to a state little short of asphyxiation. It is with factors that lead to this anomally that I now desire to deal.

Following the above Professor Lewes considered the composition of air, the functions of oxygen and nitrogen, the presence of CO_2 and other products, the regeneration of air by vegetation, and the rapid inter-diffusion of the various constituents of the air. He reviewed the contamination of air by human processes, and restated the common allowable limit of CO_2 in air to be breathed (6 parts in 10,000). It was stated that when the contamination was not by respiration the proportions might rise much higher, even to 20 parts in 10,000, without injury to health, and that it was the organic matter given off from the lungs and tissues during respiration that it is essential to remove from the air. Concerning the presence of CO_2, Professor Lewes said:

In all processes of ventilation, the great factors which enable us to change the atmosphere in our dwelling rooms are the air currents set up by alterations in temperature and inter-diffusion between volumes of air at different temperatures; and it is this which gives coal gas its great advantages as an illuminant over electric lighting. Using an incandescent mantle on an atmospheric burner, about 4 cu. ft. of gas per hr. are consumed; and this gives 2 cu. ft. of carbon dioxide, which would very soon suffice to raise the proportion of carbon dioxide above the sanitary limit of 6 parts in 10,000. But though everything be done to render the room as air-tight as possible, it will be found that the proportion of carbon dioxide is enormously less than it should be by theory; this being due to the fact that alteration in the temperature of the air of the room sets up currents and actions which tend to bring about a change of the atmosphere.

FIG. 6. BASE OF ROOF TRUSSES AT EXPANSION END, DURING ERECTION.

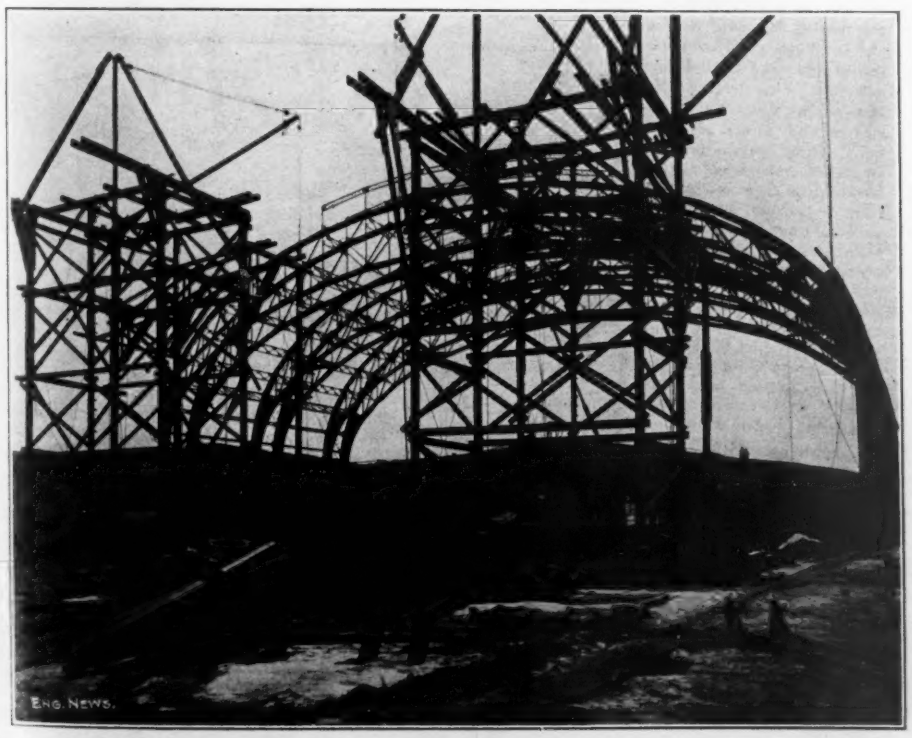

FIG. 7. VIEW OF TOWER TRAVELER USED IN ERECTING ROOF FRAMING OF RIDING-HALL.

THE VALUE OF DIFFUSION.—Carbon dioxide is a gas considerably heavier than air;—so much so, indeed, that it can be poured from one vessel to another almost like a liquid. But, like all other gases, it is expanded by heat; and as the foul air coming from the lungs, and containing some 5% of carbon dioxide, is at practically the temperature of the body—i. e., 98° F.—it at once rises towards the ceiling, while the products of combustion from the gas burner, being at a still higher temperature, also rush up to this point, so that the foul air is always to be found at the top of the room. One might think this foul air when cooled down would descend into the room again. But here comes into play the process of diffusion—a process by which gases, instead of arranging themselves, like other forms of matter, according to their weight, undergo a mingling or diffusion, the rate of which is dependent upon their weight; a light gas mixing rapidly with others, while a heavy one diffuses more slowly. It is found that, once mingled, the gases remain in perfect admixture; so that in the present case the heavy carbon dioxide will not again separate from the air into which it has become diffused.

This so-called diffusion of gases will take place with even greater rapidity through porous solids than when the gases are left simply in contact with each other; and as the plaster of the ceiling and the bricks or other building material of which our walls are composed are full of minute openings or pores, they allow gases to diffuse through with considerable rapidity—the force of diffusion being aided by a second force called capillarity. The result is that, even though the ventilation of a room has been neglected, and no proper outlet has been arranged at the top for drawing off foul gases, diffusion through the ceiling and the walls in the upper part of the room provides so rapid an egress for the hot gases, that they have not time to mingle with the air in the lower portion of the room, while fresh air is being constantly drawn in through every crack and crevice left by the jerry builder.

GAS LIGHTING AS AN AID TO VENTILATION.—An interesting series of experiments, the results of which are shown in the accompanying table, shows conclusively that, taking an ordinary dwelling room lighted by gas and then the same room lighted by electricity, the air of the lower portion of the room, if one or two people only are present, is as pure with gas lighting as with electric

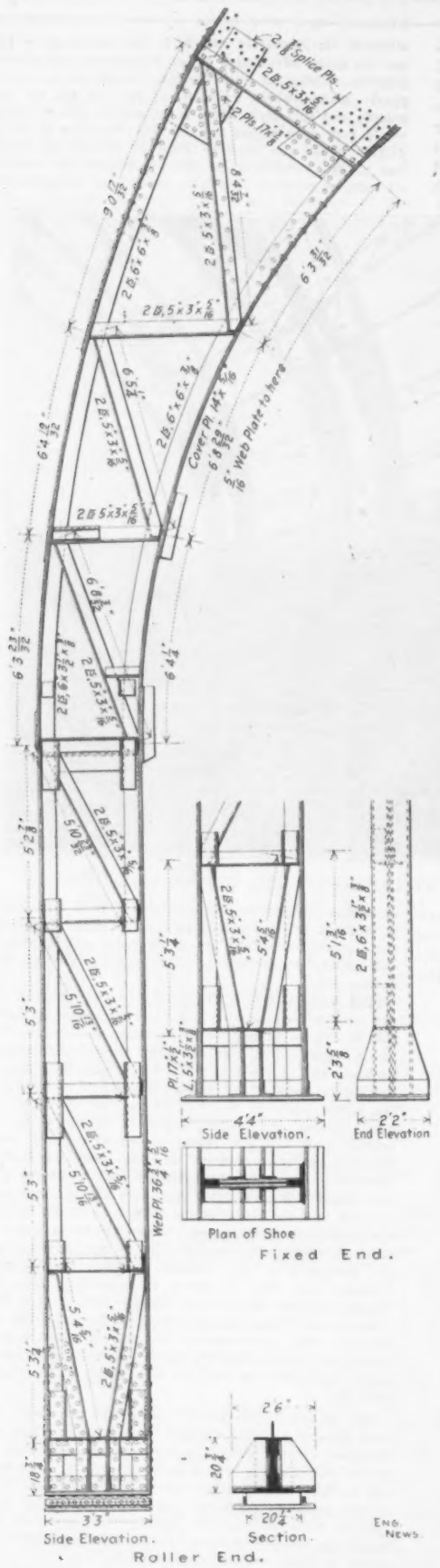

Fig. 8. End Sections of Roof Truss of Riding-Hall.

lighting, while if a large number are present, the advantages are enormously in favor of gas—the air with electric lighting becoming rapidly so organically impure as to be positively dangerous to health.

If a number of people are in a room, the organic exhalations as well as the carbon dioxide and water vapor evolved during respiration rise, and, reaching the level of the gas burners, are rapidly swept up to the ceiling by the rush of hot gas from the burner—the flame and heat destroying and charring a large proportion of the

DISTRIBUTION OF CARBON DIOXIDE IN THE AIR OF A DWELLING ROOM (CAPACITY 2,700 CU. FT.) WITH GAS AND ELECTRIC INCANDESCENT LIGHTING.

GAS LIGHTING.—Two Welsbach "C" burners (on pendant), each consuming 4 cu. ft. of gas per hour, and giving 140 candles.

	Carbon dioxide, parts per 10,000.	Temperature, Deg. F.
Outside air.....	3.0	61.0
Between joists.....	6.0	66.0
Ceiling level.....	44.0	74.7
Breathing level....	5.0	63.0

ELECTRIC LIGHTING.—Three 16 c. p. incandescent lamps.

	Carbon dioxide, parts per 10,000.	Temperature, Deg. F.
Outside air.....	3.0	61.0
Between joists.....	4.0	61.5
Ceiling level.....	9.0	62.5
Breathing level....	6.0	61.7

germs. The hot air reaches the ceiling and diffuses through the plaster and walls in the upper part of the room, and in doing so the charred organic matter is left behind, filtered off on the surface of the plaster, and rapidly causes that discoloration of the ceiling which is invariably found in a town atmosphere above the gas burner, and which is often wanting with country air. That this is the case is amply verified by the fact that if beams are present at the back of the plaster, diffusion is prevented at these points, and their position is plainly mapped out on the discolored surface.

When the room with its occupants was lighted by electric light there was no rapid uprush in this way of the products to the ceiling, and the organic impurities and carbon dioxide leaving at body temperature remained diffused throughout the whole of the atmosphere of the room, causing a far more rapid fouling of the air and injury to health. If such a room were entirely left for its ventilation to diffusion through the walls, it would soon acquire that sour smell which is noticeable in many rooms of the poor, in which, in order to keep in the warmth derived from their own bodies, all ventilation is cut off. This smell is due to the decomposition of organic matter filtered off during diffusion by the wall surface and undergoing putrefactive decay, giving the offensive odor, the only way to get rid of which is to strip the paper from the walls and lime wash them as well as the ceiling. Then, and then only, does the smell pass away.

When, however, this same diffusion through the ceiling and upper part of the walls of the room takes place in a gas lighted room, this unpleasant human smell, so characteristic of the "tube" railways, is never detected, as the small quantity of sulphur compounds present in the gas (as was shown by researches by Mr. Otto Hehner and Dr. Rideal) is largely absorbed and fixed by the lime and lime salts present, and acts as a disinfectant, destroying all forms of germ life. Here, again, the hygienic superiority of gas is manifest, as in a gas lighted room or hall not only are the germs present in the air, and often of an infectious character, destroyed and burnt up by the flame itself, but also undergo destruction and disinfection from the trace of sulphur dioxide present in the products of combustion — an action which is entirely wanting when the illumination is due to incandescent electric light.

It will be noted throughout that Professor Lewes' statements refer to coal-gas product and not to the common water-gas. While the experiments and deductions are interesting, they will not, in this country, be generally accepted. In some ways the statements conflict; for instance, it was said:

An interesting point also brought out by the experiments I have made is that it is really the position of the gas light above the level of the head of the chandelier which causes this hygienic advantage, and that if the gas is burning in table lamps the cooling of the products in their passage up to the ceiling largely does away with the ceiling action, and the air of the room may become as foul as when it is unlit, or lighted by electric light.

This would seem to so limit the claimed hygienic value of gas lighting that the condition before stated in regard to the lecture hall might be due to changed ventilation.

THE DESIGN OF TIMBER HOWE TRUSSES.*

By R. BALFOUR.†

In certain locations where timber is plentiful and transportation expensive it may still be necessary to use the fast-disappearing Howe truss in railway construction. In view of the heavy train loads now in comparison with those of the last generation, whne this type of truss was in more general use, certain details of design and construction must be adjusted to meet the changed requirements. The writer has had charge of the construction of many large Howe truss bridges on the Canadian Pacific Ry. and is of the opinion

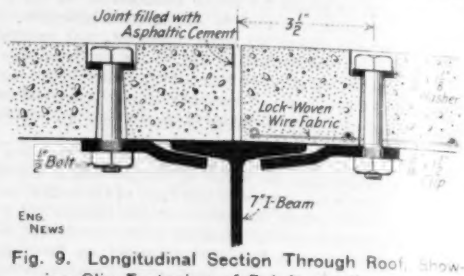

Fig. 9. Longitudinal Section Through Roof, Showing Clip Fastening of Reinforced-Concrete Roof Slabs Over Riding-Hall.

that with proper care in framing and erecting, and with the right kind of material these timber trusses can be built at a less cost than steel, especially where timber is plentiful, and will have lives many years longer than are usually accredited to them.

In the accompanying figures a typical design is submitted for a ten-panel, 150-ft. span, Howe truss, single-track railway bridge, 25 ft. between lower and upper chords and of 16-ft. clear width. The stresses were computed for the heaviest loads now specified by the Department of Railways and Canals for Canada. This load calls for two locomotives each weighing 360,050 lbs. followed by a uniform load of 4,750 lbs. per lin. ft. Some of the special points of design are hereafter noted.

The prevailing practice of putting the rails di-

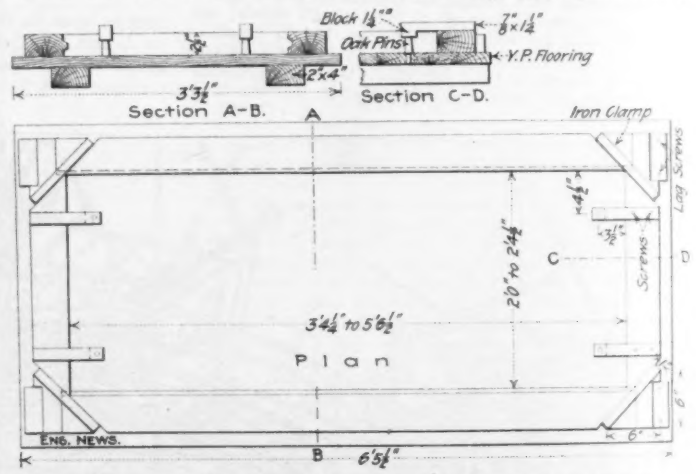

FIG. 10. FORM FOR REINFORCED-CONCRETE ROOF SLABS.

rectly on the floor beams has been abandoned. This is due in part, to the enormous load which the lower chord, in the case of a through span, would have to carry as a beam, and also to the uncertainty of the strength of the floor beams with a wheel load of nearly 50,000 lbs., which might, at the joint of the rails, be almost entirely applied to a single floor beam. Two floor beams for each panel have therefore been introduced. These floor beams are made of three 6 × 18-in. pieces, bolted together and supported in the center by truss rods. The space between the floor beams is carried on 10 × 14-in. stringers, with 8 × 8-in. ties. These floor beams should be amply strong, as they are designed to carry a load of 200,000 lbs. per panel. In order to admit of this deeply trussed floor beam, two lateral rods have been placed at each panel point in the lower chord, one on either side of the panel point.

*See article by same author on Design and Construction of Wooden Trestles, June 6, 1907, p. 611.

†38 Somerset St., Ottawa, Ont.

The direction of the thrust from the lateral brace extends outwardly a short distance beyond the center of the chord. but the strength of the lower chord should be great enough to carry this eccentric loading. The upper chord will have the usual lateral rod to each panel. It will be noticed that the first and second panel of the counter-braces are abutted to the main braces, and secured thereto with castings and bolts. This is necessary, owing to the fact that nearly all of the space of the width of the girders is required for timber for the main braces, so that there will be no opportunity of placing the counter-braces between the main braces, in order to get the necessary strength to carry the great load. It will also be noticed that two sets of vertical truss rods have been introduced at each panel point, instead of the usual single set. This makes the truss rods smaller, more easily handled, more easily screwed up, and less liable to fail, as there are six rods, whereas ordinarily there would only be three, so that the breaking of one rod would only be one-sixth of the total number, whereas one faulty rod amongst the three would be one-third of the members in that panel point.

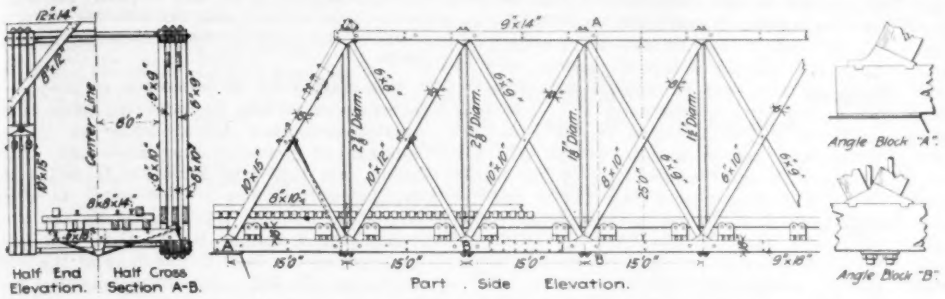

FIG. 1. DESIGN OF TIMBER HOWE TRUSS RAILWAY BRIDGE.

The next departure from the general practice will be noticed in the case of the splicing of the lower chord leaves by means of a boiler plate clamp. This clamp admits of definite calculation of all the strains which will come upon it, and no reliance whatever is placed on the shearing strength of the bolts, as is the usual rule-of-thumb practice in most other lower chord packings. For instance, assuming that the total tension on the lower chord would be 1,136,000 lbs., with eight chord leaves in the lower chords, there would be 142,000 lbs. of tension on every leaf in the chords in the center of the span. It is assumed that the net area, after the framing of the chord leaves for the splicing, is 7×16 ins., which gives a net area of 112 sq. ins., and a load of 142,000 lbs. would stress the wood at 1,268 lbs. per sq. in. in tension. The shear of the wood, parallel to the fibers, is 87 lbs. per sq. in., or 1,620 sq. ins. Compression on end wood on each splice gives a crushing strain of 1,314 lbs. per sq. in. on 108 sq. ins. (6×18 ins. $\times$ 1 in.). There are two steel clamps, each $\frac{5}{8} \times 18$ ins. After deducting 6 ins. for rivet holes and bolt holes, there is left a net width of 12 ins., making a net cross-sectional area of 15 ins. This gives a tensional strain on the steel boiler plate of 9,466 lbs. The strength of the rivets between the boiler plate and dados is amply strong, so that the tensile strength of the splice can be relied on, and the splice is fully as strong as an original piece of timber the full length of the span 7 ins. thick and 16 ins. deep.

This clamp has been used since 1887 on the Canadian Pacific Ry., both for repairs on the mountain section and on all Howe trusses of the Crow's Nest Pass branch. When the clamp is framed tightly and then expanded by heat and bolted quickly onto the chord leaf its contraction in cooling actually shortens the chord leaves that are spliced, and that to such an extent that the first span that was sent out from the work shops actually had too much camber to it, owing to the lower chord being slightly shorter than would have been the case had ordinary clamps been employed. It is not at all desirable to put the clamp bolts all the way through the four chord leaves, for in practice it is almost impossible to keep the boiler plate clamps snugly up to the spliced chord leaves, as the shrinking of the four chord leaves will allow sufficient space for the clamps to work away from the spliced timber. It is absolutely necessary that the bolts holding the clamps to the spliced wood should be of such length as to pass only through the two boiler plate clamps and the one piece of wood, otherwise failure is liable to occur.

Another point of variation from the usual practice is in the lateral braces. The lateral blocks are grooved out at each end to fit against the rod. On one side of the truss the lateral block is placed on top of the lateral rod, and on the other chord, directly opposite, the lateral block is underneath the lateral rod, so that each lateral brace extends from one lower chord to the opposite one resting on top of the other without any half checking. The two lateral braces are bolted together at their intersection, and the only work required is to cut them to their proper length.

In no case are two pieces of wood to touch each other; where in the ordinary practice this would occur, a thin sheet of black iron is to be interposed between them. All the timber is expected to be planed, and preferably the framing of the span should be done by machinery; all daps for packing blocks and hooks of the clamps should be cut out with a gainer head, as the work can be done more cheaply and better by machinery than by hand.

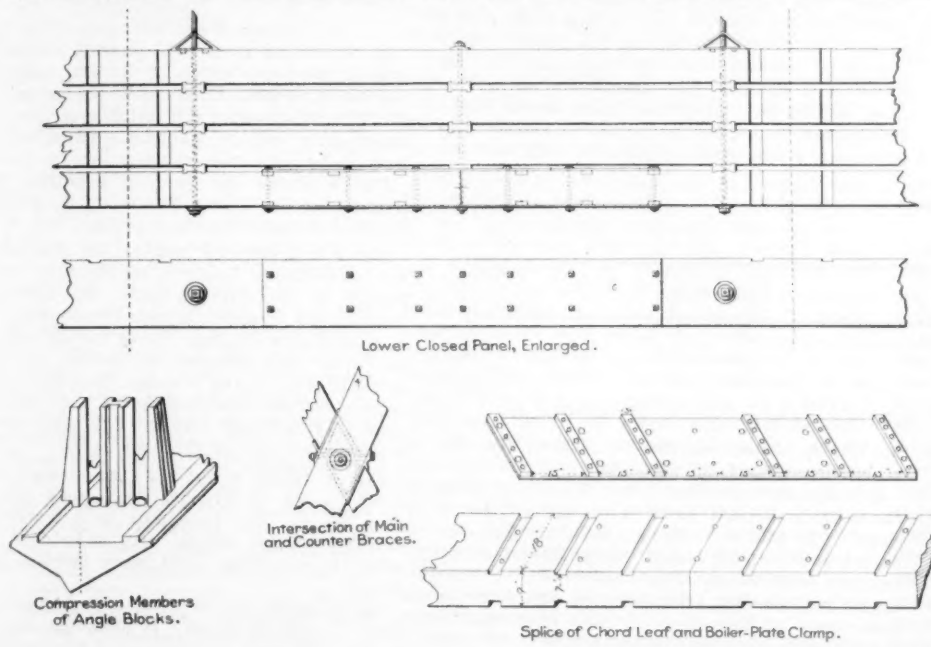
Lower Closed Panel, Enlarged.
Compression Members of Angle Blocks.
Intersection of Main and Counter Braces.
Splice of Chord Leaf and Boiler-Plate Clamp.
½ Plan of Upper Chord.
½ Plan of Lower Chord.

FIG. 2. DETAILS OF TIMBER HOWE TRUSS.

CAUSES OF LEAKS IN LOCOMOTIVE BOILER TUBES.

The gist of a paper presented by Mr. M. E. Wells* at the fortieth annual convention of the American Railway Master Mechanics' Association on June 14, on "Causes of Leaks in Locomotive Boiler Tubes," will be of undoubted interest to our readers in the railway field.

TREATMENT OF SUBJECT.

The author of the paper has resolved the subject in hand into two broad divisions, viz., leaks due to mechanical causes and those due to temperature variations. Each of these main headings he subdivides into other headings. For enabling a clearer grasp of the subject as a whole, and facilitating the presentation of the main points of Mr. Wells' paper, we have made the following outline and shall present the various causes in the order in which they occur therein:

I. LEAKS DUE TO MECHANICAL CAUSES.
- A. Defective work at time of first setting of tubes.
- B. Poor and hasty work in making repairs.
- C. Vibration of tubes in service.
- D. Wearing out of tube-ends by abrasive action of cinders.

II. LEAKS DUE TO VARIATIONS IN TEMPERATURE.
- A. Equal variations.
- B. Unequal variations.
  - a. Ingress of coil air (?).
  - b. Deposits of scale.
  - c. Varying water temperatures.

METHOD OF OBTAINING INFORMATION.

To secure new information on the subject, Mr. Wells had sent out, to the principal railways in this country and abroad, a list of questions bearing on leakage causes. Commenting on this letter Mr. Wells says:

> We made a mistake in saying, in the letters to foreign railways, that the questions referred to iron and steel boiler tubes and tube-plates, as we use no other kind in the United States. On account of this, a number replied that they could give us no information, since they use only copper for fire-boxes and tube-plates, and, in some cases, copper and brass tubes.

Replies received from abroad indicated that

*Assistant Master Mechanic, Wheeling & Lake Erie R. R., Columbia, O. (Massillon P. O.)

copper and brass tubes are in many cases being replaced with those of soft steel. In early cases the steel tubes were reinforced with copper safe-ends at the fire-box tube-plate, but the use of these is being discontinued and some foreign roads are setting the soft-steel tubes directly into the copper tube-plate.

Some of the foreign roads, realizing that the causes of tube leakage are practically the same

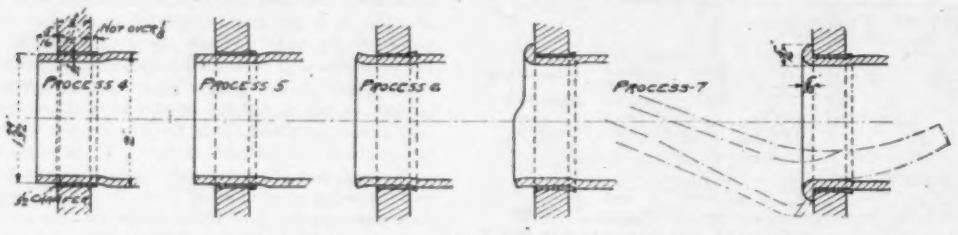

FIG. 1. METHOD OF SETTING BOILER TUBES, UNION PACIFIC R. R.

1. All scale must be removed from flue hole by small air drill with small emery wheel on shaft of drill.
2. All scale must be removed from end of flue. This can be done by holding a square file on end of flue while being cut to length and flue is revolving.
3. Copper of proper thickness inserted and expanded in flue hole. Edge of copper should be 1/32-in. from face of flue sheet.
4. Flue inserted and pinned out.
5. Rolled with roller expander.
6. Expanded with Prosser sectional expander.
7. Beaded with standard beading tool.

whether the tube-plate be of copper or of steel, sent very full replies. The author states that these recorded causes from abroad were substantially identical with those reported by our own roads.

RESUME OF REPORTED CAUSES. SUGGESTED REMEDIES.

Taking up the causes as they occur in the foregoing outline, and in some cases suggesting remedies for the troubles:

I. LEAKS DUE TO MECHANICAL CAUSES.—A.—Defective work at time of first setting of tubes: This is treated as a very insignificant cause of leakage; in our largest boilers, however, "the most skilful job that it is possible for a skilled mechanic to do on the bottom tubes in the fire-box will hold, at most, but a few days."

B.—Poor and hasty work in making repairs: This is, says the author, a much more prolific source of trouble than any one of the other causes under this main heading. The remedy is, briefly, "take time to do it well."

C.—Vibration of tubes in service: That tubes vibrate vertically is substantiated by a case found by the author, of a 19-ft. tube set so close to the bottom of the shell that a rivet-head had worn a hole through the tube wall. Such vibration is not regarded as serious in the way of loosening the very simple tube-settings in the smoke-box tube-plate.

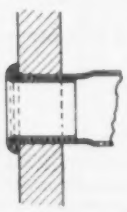

Fig. 3. Boiler Tube Setting of Southern Ry. of France.

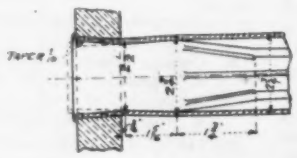

Fig. 4. Boiler Tube Setting of Northern Ry. of France.

D.—Wearing out of tube-ends by abrasive action of cinders: The Northern Ry. of France suggested this cause; the Pennsylvania R. R. reports the same or a similar condition, referred to as "burnt-off and cracked heads," due to shallow fire-boxes. Further on in the paper the author says, in regard to a kindred phase of this:

> I want to say a few words about the idea that much of this trouble in line with the firedoor comes from overheating and burning off of the tube ends. In my opinion, there is much misconception on this point. This trouble is the direct result of constantly changing and varying temperatures on the water side.

This throws it into classification II; and Mr. Wells cites a case to prove his contention:

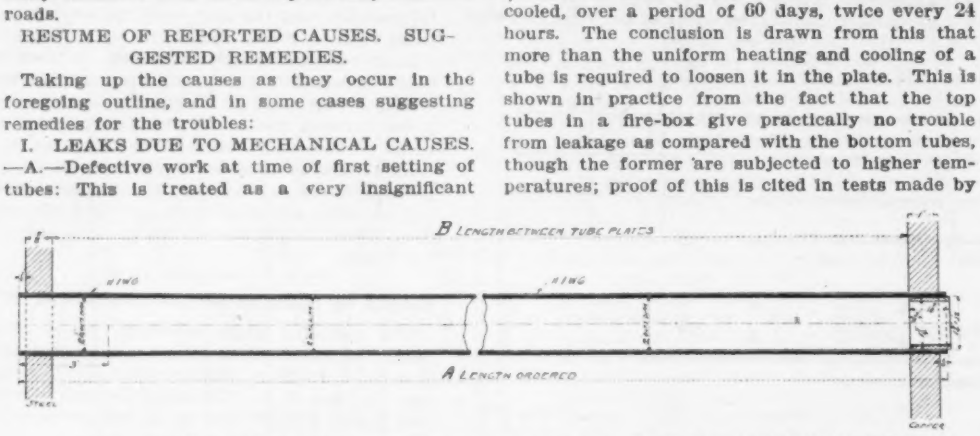

FIG. 2. BOILER TUBE AND METHOD OF SETTING, LANCASHIRE & YORKSHIRE RY.

II. LEAKS DUE TO VARIATIONS IN TEMPERATURE.—A.—Equal variations: The negligible amount of damage done to boiler-tube joints—i. e., tube-ends fitted into a tube-plate—is shown to have been proven experimentally, in a special test involving microscopical examination of a joint alternately heated to 450° F. and cooled, over a period of 60 days, twice every 24 hours. The conclusion is drawn from this that more than the uniform heating and cooling of a tube is required to loosen it in the plate. This is shown in practice from the fact that the top tubes in a fire-box give practically no trouble from leakage as compared with the bottom tubes, though the former are subjected to higher temperatures; proof of this is cited in tests made by the Chicago Great Western Ry. (Proc. Am. Ry. M. M. Assoc., 1904, pp. 220-223).

B.—Unequal variations: This is declared to be the most important division of the subject in hand. The author takes up, first, (a) "the apparent cause of all causes. It is always given, and has been talked about more than all other causes put together. The opinion regarding the importance of this cause is just as strong in Europe as it is in the United States." On this point we may quote the author at length:

> I refer to cold air. The opinion regarding the direful effects of cold air in causing leaks in locomotive boilers is so universal and so strongly held that, were I not so sure of my own position on the subject, I should hesitate to undertake the task of trying to show that its effect is really not very potent to cool boiler tubes and cause leaks.
>
> In answer to one of the questions sent out for information, cold air, as a cause of leakage, is the most universal answer given. In the same list of questions I asked the following: "With tubes and tube plates free of incrustation, can cold air entering the fire-box cool the metal any appreciable amount below the temperature of the water in the boiler? " The majority of the answers to this question is "No"; and yet every one of the gentlemen so answering has given, in another part of his answers, cold air as a cause of tube leakage. I confess that I anticipated this when the questions were formulated.
>
> If cold air entering a fire-box cannot cool a tube or boiler-plate any appreciable amount below the temperature of the water on the other side, what serious effect can it have in producing unequal variations of temperature, which are the real causes of leaks? In arriving at this conclusion I am fully cognizant of the fact that an incrusted tube or sheet may be slightly cooled, on account of the inability of the heat of the water to pass through the scale to the tube or plate. But ordinarily and with the ordinary scale formation, the cooling on account of cold air is practically harmless as a cause of leaks.

The matter (c) of leaks due to unequal temperature variations in the water space is briefly treated—reference being made to the great amount of previous discussion and literature along this line—and attention is called to the injudicious injection of feed-water as a prolific source of trouble. Tests made by the Chicago, Burlington & Quincy R. R., along this line, are reported in the 1904 Proceedings of the Association, pp. 231-241. Adequate education of enginemen by the motive-power department, in the potential troubles from this direction, is strongly recommended. The author also advocates, as supplementary betterment, adoption of new methods of feeding and the heating of feed-water. An English road is mentioned (the London & Southwestern Ry.) which passes its feed-water through the smoke-box for heating it; this road reports: "We have little or no trouble with leaky tubes—not such as to require attention between trips."

VARIOUS NATIONAL PRACTICES IN TUBE SETTING.

In connection with I-D—wearing out of tube-ends by abrasive action of cinders, and kindred causes—a number of sketches are given in Mr. Wells' paper showing the methods of tube setting reported by various countries. These will be of interest by way of comparison.

Fig. 1 shows the process employed in this country by the Union Pacific R. R., practically the United States standard process.

Fig. 2 is a drawing sent by the Lancashire & Yorkshire Ry. of England, showing the tube and ferrule at the fire-box end; the ferrules are welded, and of Swedish high-carbon steel—those of solid-drawn weldless tubing having been found too soft. The ferrules are driven in with an ordinary shift. The fire-box tube-plate is 1-in. copper, and the front tube-plate 7/8-in. steel. This road does not bead over the tube-end, while the Northeastern Ry. of England does.

Fig. 3 shows a tube-end as treated by the Southern Ry. of France, which rolls and beads over the end and then puts in a ferrule. The sketch shows a ferrule with a head or collar, which is sometimes used when ferrules are replaced.

The Northern Ry. of France uses tubes of soft steel, 77 mm. (2.75 ins.) in diameter, swaged to 66 mm. (2.6 ins.) and rolled and beaded into the copper plate, as shown in Fig. 4. The Royal Bavarian States R. R. employs a copper safe-end on an iron tube (Fig. 5). It is merely rolled and beaded in the fire-box, and only rolled in the front end. Attention is directed to the increased strength of the safe-end, and the avoidance of shimming at the front end.

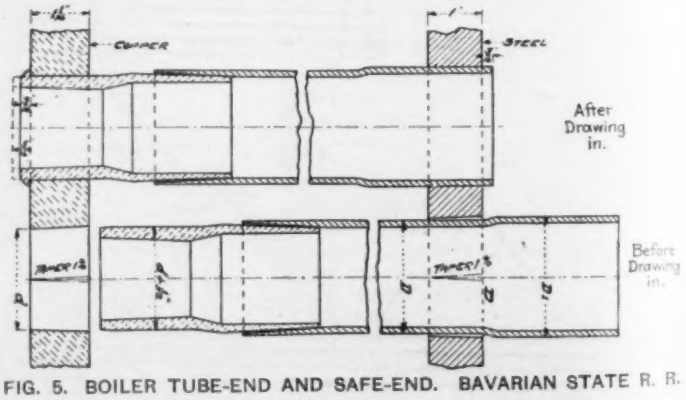

FIG. 5. BOILER TUBE-END AND SAFE-END. BAVARIAN STATE R. R.

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Another fallacy regarding standards for fixing water rates under private ownership has been exposed. Fifteen years ago some ignoramus or knave (we do not know who or which) inserted a clause in a water company franchise or ordinance passed by the city council of Denver, Colo., to the effect that after a certain future date the water rates charged in that city should or might be based on the average of the rates charged in Chicago, St. Louis and Cincinnati. In a decision handed down by the Colorado Supreme Court (see Denver Republican, July 6, 1907), Judge Le Fevre held that it was impossible to determine such an average, owing to the wide differences in charging for water in the three cities. In the trial court weeks were spent in trying to make up the proposed average, with results that can be understood by any one familiar with water rate schedules. But foolish as was the Denver rate clause, it is reason itself as compared with an earlier rate provision, in a Des Moines franchise. This one provided that the rates in Des Moines should be no more than the average of the rates charged in other cities of the United States having works similarly situated, whatever the latter clause meant. That provision came to naught, also, when it got into the courts. Some day our cities and franchise companies will learn that the only proper basis for fixing charges to private consumers is the cost of the service in the city directly concerned; and some day the public will insist on knowing what that cost is.

Certain observations made at the Syracuse break in the Erie Canal, where a masonry arch crossing over a creek broke through, afford the first reasonable ground for acceptable explanation of the collapse. As noted briefly on page 219 the piers and abutments rested on a timber foundation, apparently not a very good one. There were tie-timbers between the grillages of the two abutments of each arch. Whether or not these were intended to take part of the arch thrust does not seem to be determinable, as there are practically no detailed records of the earlier work on the canal in existence, as we understand. In fact, when the break occurred there was no drawing showing any piles or other foundation timber, and the presence of piles could only be presumed, from their having been found in other old structures of the canal. The physical examination first showed the nature of the foundation. It would appear that the arch thrust at the abutment, which ordinarily in such structures is resisted by the friction of the foundation strata, must have gone largely into the tie-timbers in this case, and been taken up by foundation friction only after the failure of these timbers by decay or other causes. Whether the pile foundation was of sufficient strength to take this thrust is not known. If it were not, the failure of the tie-timbers would of necessity entrain a sudden collapse. If it were strong enough, the action of percolating water, leaking down through the earth filling of the canal bed under a hydrostatic head of some 20 ft., would tend to wash out the earth around the pile-heads, little by little, and thus progressively weaken the abutment foundation. The lateral support of the abutment by the pressure of the earth behind it would similarly be subject to reduction by the erosive action of water leaking down along the back of the masonry. Under such conditions, failure could only be a question of time. If this explanation of the accident be appropriate, and the conditions under the adjoining arches are similar, the safety of the entire culvert is questionable until permanent reconstruction of the foundations has been carried out.

The unpleasant consequences which may result from the absence of record drawings of existing structures are graphically illustrated in the Syracuse failure. But the case also indicates that old structures, especially if of unknown constitution, need to be watched over with an anxious eye, to detect the earliest symptoms of unfavorable change.

The cost of forest planting by the Pennsylvania Railroad, figures for which are given elsewhere in this issue, appears to be so moderate as to warrant the hope that similar forestry work will be carried out by many individuals in the near future, as well as by railway and other corporations. The greatest drawback to forest planting is the long period that must elapse before any return on the investment will be received. This, as Mr. Sterling points out, is of less concern to a corporation than to a private individual, but in the near future we may expect to see many private individuals gladly entering upon long-time forestry investments for the good of posterity, whether of next kin or no kin. There are possibilities of forestry revenue, however, well within the life expectancy of a young man or even one of middle age, especially if trees suitable for railway ties, fence posts and like purposes not demanding large timber are planted.

As a result of organized effort, Mr. Sterling, Forester of the Pennsylvania Railroad, has reduced the cost of planting seedlings by nearly half, bringing it down, in 1907, to an average of $11.29 per thousand or $15.93 per acre, for both the seedlings and the labor. This, of course, was for work on a relatively large scale, involving nearly a half million seedlings; but the work was somewhat scattered and was done under other conditions not wholly favorable.

When one considers how much relatively unproductive land, well suited to forest planting, there is in various parts of the country, and how rapidly the available timber supply is failing, and how speedily timber prices are rising, it seems a pity that more forest planting than has yet been other than dreamed is not being undertaken on every hand. Much of this virtually waste land is actually deteriorating in value, through losses of top soil by erosion and through growing up to timber of low value or to worthless bushes. Even on a small scale many of these non-productive areas could be planted at $25 or perhaps $20 per acre, assuming that all seedlings were bought and all labor hired at market rates. For most small plantings, seedlings would doubtless be cheaper, and also of more certain growth, if bought rather than raised in home nurseries, but considerable areas, now embraced in small semi-abandoned farms, could be planted without requiring much or any hired labor. While the farmer's time should, in any proper system of accounting, be charged against the cost of any forestry work done by him, yet it does make a big difference to the ordinary small farmer whether he has to pay out what to him is usually a scarce article, cash. With a little instruction, any farmer could plant forest seedlings, thus reducing his actual cash outlay to a few dollars per thousand trees or per acre planted.

For years to come, timber users may congratulate themselves if farmers do no worse than conserve their present rapidly diminishing wood lots and small tracts of merchantable timber trees. Relatively few farmers, we fear, will plant new areas. But corporations that for one reason on another find themselves in possession of considerable areas of naked and largely unutilized land, and at the same time are feeling the growing scarcity and rising price of various forest products, are likely to enter upon reforesting with the zeal, intelligence and promise of good results that seem to characterize the work of the Pennsylvania Railroad.

There are many reasons why the whole subject of forestry should be of great interest to the readers of this journal and also why our readers can contribute largely to the adoption of national forestry work in the United States. There are few among them who cannot bring about the planting of some little amount of land in trees, or perhaps themselves do the planting: a hundred acres, or ten acres, or even one acre. And each one, without exception, can aid in much-needed educative work, for both the planting of new and the preservation of old forest areas.

The clearance between cars on double-track street railway lines in city streets has recently been a subject of discussion in Chicago. The Board of Supervising Engineers (representing both the city and the street railway companies) which is charged with the work of planning and carrying out the extensive improvements so much needed by the street railway system of that city has decided upon a spacing of 9 ft. 8½ ins. between centers of tracks. The new cars are to be 9 ft. in extreme width, leaving a clearance of only 8½ ins., and some of the daily papers have been claiming that the clearance should be such as to allow persons to stand safely between the cars. The questions before the Board in regard to width of clearance presented three alternatives: (1) A width amply sufficient to allow any person to stand between cars with safety; (2) a width sufficient for ordinary or medium-sized persons, but which might result in injury to a large or stout person; (3) a width so narrow that nobody would attempt to stand between cars. The Board was of opinion that to meet the first condition would necessitate such a spacing of the tracks as to interfere with vehicle traffic on the sides of the streets, especially as allowance must be made for wagons to stand at or back up to the sidewalk. The suggestions for a wide clearance range from 24 to 42 ins., and it is difficult to determine the limit of safety. To meet the second condition, there would also be liability of interference between the cars and other vehicles, while there would always be an uncertain degree of danger to persons running the risk of getting between the cars. With some of the older cars now in use it is often quite practicable for a clear-headed person to stand between them, but a nervous or excited person (or one above the average size) would be liable to injury. Rather than adopt a compromise, the Board has preferred to adopt a minimum clearance, and to let the public understand that it is as dangerous to stand between the tracks as upon them. In other words, the people must keep entirely clear of the track space when avoiding cars in crossing the street. It has also been decided to make the spacing uniform throughout the city, whether on narrow or wide streets, as it is considered that it would be unwise to give any exception to the above rule. It is an open question, however, whether it would not be better to adopt

a wider spacing on wide streets outside of the business district; but if allowed here, and here only, the space should certainly be ample to protect against danger.

The provision of a wide clearance space between cars, as proposed in some of the popular discussions, is impracticable in very many of the business streets in Chicago, the general width of which is 66 ft., with a 38-ft. roadway. The 80-ft. and 100-ft. streets are in a minority. With a 20-ft. strip covered by tracks and cars, the ordinary street has only 9 ft. between the car and curb, which is narrow enough in the congested condition of street traffic in the busy district of the city. Under the present arrangement, with the possibility of persons standing between the cars, a number of accidents have occurred, and it is believed that the close spacing will tend to increased safety rather than to increased danger. In a statement issued by the Chicago City Ry. in 1905, when it began to introduce cars similar to these since approved by the Board of Supervising Engineers, it was remarked that the cars must be either narrow enough for persons to stand safely between them (which would limit the width to about 7 ft. 6 ins.), or wide enough to get full benefit of the intermediate space and to leave no question as to the clearance being too small to permit people to stand between the cars. With a distance of 11 or 12 ins. there is liability of people attempting to stand between them and so getting injured, while a closer spacing will deter or prevent such an attempt. The track spacing at that time was 9 ft. 5 ins., and the minimum clearance with the new cars was 5 ins.; this is now increased to 8½ ins. by the new standard spacing of 9 ft. 8½ ins. adopted by the Board of Supervising Engineers. The clearance in this case, and in the other cases noted below, is the minimum amount; this is usually the clearance between eaves of roofs, but in many cases there are molding strips or projecting ledges on the body which extend as far as (or even farther than) the eaves. In Minneapolis and Kansas City the spacing is 10 ft.; in Detroit it is 9 ft. 9½ ins., with cars 8 ft. 9 ins. wide. According to the statement already mentioned, the conditions in some other cities are as follows:

City.	Track spacing, ft. ins.	Min. clearance between-cars, ins.
Brooklyn	10 2½	24
Buffalo	9 0	3
Cleveland	9 1½	7
Philadelphia	8 6½	6½
St. Louis	10 2	13

ON THE STUDY OF MATERIAL.

The ancestry of the engineer, we may presume, includes both handicraftsmen and thinkers—natural philosophers. Many of his forefathers, indeed, were both the one and the other, and these no doubt include all the great names in the family tree. To take an illustration: Neither the mere master-workman nor the mere schoolman could have planned and directed the hewing out of the temples of Egypt, or the erection of the aqueducts of the Romans. The originators of these works must have combined both personalities within them. So also we find, much later, that the philosopher who discovered one of the very foundations of engineering theory, the resolution of forces, was "Stevinus, that great mathematician and *engineer*" who invented a "celebrated sailing chariot." It is true that not all great men who possessed the two characters conjoined graced the ranks of engineering, and that many thus missed their true vocation. For example, one of the most devoted of philosophical thinkers, Pascal, was sufficiently practical to invent the first mechanical improvement on the abacus, and, more than this, he himself actually constructed his calculating machine, yet he never became an engineer. But on the converse proposition we can say with reasonable certainty that in the early epochs of engineering work no man ever attained to great achievements who was not endowed with both the faculty of keen original thinking and a high order of instinctive knowledge derived from the exercise of handicraft.

What this knowledge is that these primeval engineers derived from their manual experience, in other words, what constituted their "fingerwise" learning (as a great modern engineer has called it), is not easily put into words. There can be no doubt that they learned much of forces, of mechanical relations, of the elements of machines, and the like. In a less definite way they must have acquired great experience in the strength of structures, as is shown in their dams, their arches, and even so slight a detail as the entasis of the classical columns. They probably also obtained a knowledge of the relation of motions per se—kinematic facts. One thing is certain, however: they learned thoroughly and permanently the peculiar characteristics of different things, and the special adaptability of each substance to different purposes, in short, the capacities and limitations of materials. This latter learning appeals to us as somewhat the most characteristic part of the equipment of the forgotten generations of engineers.

These men had genius, that is undoubted. They accomplished large things, but not through mere genius. Genius might create great dreams, but an intense practical knowledge was necessary to convert the dreams into realities. There had to be an unerring instinct, derived from their practical or manual or "fingerwise" experience, to tell them (for example) what stuff would adapt itself to shape the iridescent cupolas of their dreams, giving the most practicable construction and at the same time attaining most nearly to beauty of result, the expression of perfect adaptation to definite purpose. Equally, of course, instinct and rude calculation had to show them the procedures of construction, and the ways of applying and resisting forces, and the like. But these latter requisites, though vital to ultimate success, were none the less secondary: the substance had first to be found and its proper character read into the problem; the methods and devices were merely such as the characteristics of the substance demanded, and could not endow it with capacities not inherent in it.

It may fairly be asked how far such intimate knowledge of materials as these men possessed is still required; that is, how much the engineer of to-day depends upon familiarity with the nature and spirit of materials, for successful work. The conditions under which engineering work is done have of course changed vastly. We have to-day a great accumulation of scientific method whereby we can analyze structures, actions, etc., and calculate in advance what is feasible and what is necessary. We have the help of intricate machinery and highly-concentrated power. We have a wonderfully wide knowledge of phenomena [on which in turn is founded a very large part of our engineering work]. In short, the circumstances are so radically different from those in which the early engineers lived that it seems quite impossible to make a comparison of methods. Most of the things that we do, or work with, were not even dreamed of then. Our resources—mechanical, chemical, physical, financial—are incomparably more powerful. In materials we have also advanced, since we deal with a far greater number and variety and in large part far better quality of materials than formerly. How then, may it be asked, can we expect a similarity in the mental equipment required for the engineering work of these widely different times.

In spite of the great changes just suggested, the fundamental processes composing the engineer's work have changed but little. These are: the choice of form and structure to accomplish a given purpose, the selection of material, and the adaptation of this material to the structure. Looking at these processes more closely, it will appear that all three of them center about the nature of the material employed. For, evidently, the choice of structure or form depends vitally upon the material concerned, both that which makes up the structure and that which the structure is to deal with. And in equally obvious manner the detail design and construction are determined by the material, for they consist wholly in correlating the desired structure with the nature and properties of the material. In each process, it will be seen, the material is the dominating thing. It follows at once that the value of the engineer's work depends on how thoroughly he can identify himself with his materials, and turn to account their properties.

It is true that much of the necessary knowledge of materials may be read out of reference books, and applied to the case in hand in a fixed way by calculation. This is true to the extent of our ability to translate the peculiarities of any given material into figures—and only to this extent. Now, while we may take pride in our testing machines and in our ingenious methods for investigating this or that property of a material, yet the numerical experiences cover only a small part of the ground. If this were not true, there would be fewer differences between good and bad design than are actually found; there would be little room for the exercise of experience or practical training, in engineering work; and it would be possible to train an engineering student so thoroughly that he would in all respects be the equivalent of the oldest and best-experienced engineer. The very existence of these differences is positive evidence that engineering work is very largely dependent upon knowledge and instincts that cannot be taught in schools, but are learned slowly during the post-graduate period, the real education of the engineer. To our own mind this knowledge is to no small extent a knowledge of materials.

Materials, as we mean the term here, includes not merely the stone, steel, copper, rubber, timber and the like which are ordinarily grouped under that head. It covers every substance with which the engineer is concerned, the substances which he contends against as well as those which he utilizes. Sand, earth, water, air, are materials in this sense, as is also city refuse, sewage, and smoke. In a slightly different sense, special forms of one or another substance may represent different materials. Steel shapes, for example, or hemp packing, differ sufficiently from steel shafting or hempen rope to make them different engineering materials. All these are substances which the engineer has to work with, and whose peculiarities he should know with utmost thoroughness—even though a large part of this knowledge be general or instinctive and not reducible to a specific or numerical basis.

It seems to us a proposition well worth consideration, that engineering activity of the present day rests fully as much, perhaps even more, on intimate knowledge (both exact and instinctive) of materials as that of any previous epoch. The engineer ever was, and is to-day, primarily occupied with adapting to various useful purposes the materials most suitable thereto. [On this observation, indeed, a definition of engineering might perhaps be founded, without reference to "sources of power" and the like abstractions.] Certainly, for the exercise of this occupation the engineer needs primarily a knowledge of materials, in high degree. It is true that he needs also a greatly specialized knowledge of forces, motions, phenomena, and types of construction; in fact, this he needs so greatly, in appearance, that we distinguish and subdivide engineers from each other and from laymen on the basis of the phenomena and the forms of construction they deal with. But let it be noted that the knowledge of these things is highly systematized, in part rendered almost artificial, so that rules, methods, types of practice, and the like summarize and put in simple, quickly available form a great deal of it; while on the other hand the knowledge of materials has remained a bare, unsystematized compendium of facts and observations, many of which, even, are not susceptible of written record but as in earlier times must be acquired and turned to account instinctively. And this knowledge, therefore, cannot well be systematized, cannot be put into rules, or forms of practice, and to be available at all must be well ingrained in the engineer's mind, both as general or impressionistic knowledge and as highly detailed information.

Acquiring this thorough acquaintance with materials, in large part proceeds continuously throughout the engineer's active life. In particular, much of the knowledge which springs from personally dealing with the various materials, from observing what has been accomplished with them, and from studying their successes and failures in different kinds of service, gathers slowly and automatically in the mind. Another large part, however, may be imparted in bulk during the young engineer's school years, by the ordinary methods of scholastic instruction. If this part of the lore of materials be not taught the young engineer during his period of schooling, so that he leaves his college course with a hazy and non-vital state of information concerning the substances he will be occupied with all the rest of his life, he is by so much handicapped until, at a much later period, he has made up the deficiency.

What the knowledge of materials is that may [and therefore should] be taught in the college course can be summarized in the simple phrase: all that it is possible to convey in words, figures, pictures and specimens, by direct statement or by suggestion. Enough that cannot be taught is left, in any case, to allow of constant steady increase of this initial mass of information during the post-graduate life. What can be taught includes, on the one hand, groups of facts, on the other hand a tendency of mind and a training of the physical and mental eye. The mental tendency which we would have taught is such a one as leads to an appreciation of every single material, and group of materials, not merely mechanically, in terms of their tensile strength, their insulating value, or other properties, but also in terms of source, production, stability, frequency of occurrence, cheapness, relation to other materials and processes, etc., that is, descriptively or statistically; in terms of past and present uses, possibilities and failures, that is, in the historical and economic aspect; and lastly (referring now to the useful materials only), in terms of type-forms of utilization, appropriate design, and the like, that is in what may be called the artistic aspect. The training of the physical and mental eye should be such that the subject will be able to see many of these qualities or qualifications in the material of any structure, and be able to interpret their meaning. The mass of facts and data to be taught includes those which supply the material for the appreciation mentioned, and place ready in the subject's mind the figures and facts needed for prompt judgment and proper utilization of material for any specific purpose.

How these matters are best taught is another question, and one that depends almost wholly on the teacher, the man who is to do the work. Once the proper attitude is established, by defining what is to be taught and securing for it a receptive condition, the method of attack may take a number of different forms. A great amount of fact must be presented, and its proper absorption seen to; historical and descriptive (or statistical) sketches need to be given, classical structures and elements of structures described and illustrated or shown in actual sample (not for the structure but for the material), the application of design to each individual material demonstrated, etc. The arrangement of all this matter to form a logical, digestible course of instruction is a problem of practical pedagogics which can not be solved in this place, and moreover, one which hardly concerns our present purpose.

The desiderata of instruction in materials have here been outlined in an abstract fashion, without thought of what is actually being done in technical schools toward equipping students with knowledge of materials. On referring to this phase of the matter we find first that the study of materials of construction [not of all materials; note the limitation] has a recognized place in most, if not all, technical courses, and second, that in this study principal attention is given to numerical and broadly descriptive facts. Those desiderata above suggested which are not in themselves definite facts immediately connected with the production and commercial utilization of a given material receive no explicit attention, it seems. Looking further to the question of the time spent in this instruction, we find that, since what is actually studied quite fills the allotted time, there is evidently an insufficient amount of the available time allotted to this instruction.

The time devoted to instruction in the knowledge of materials, in technical colleges, is, in fact, rather scantily measured. The curricula of two well-known technical schools were examined to obtain figures with regard to this, and from them the following list was drawn up of subjects bearing on the study of materials, and the time allotted to these subjects. In this list the fraction 8/8 denotes one hour per week continued through the four years of the course, so that something like 150/8 to 175/8 will represent the entire available attendance time of the student.

	College A		College B	
DIRECT.	C.E.	M.E.	C.E.	M.E.
Materials of construction.	3/8	2/8	5/8	4/8 (estimated)
Testing laboratory	4/8	—		
Engineering details	—	—	2/8	—
Masonry	—	—	4/8	—
Metallurgy	—	—	—	2/8
Total Direct	7/8	2/8	11/8	6/8
RELATED.				
Eng'g construction (?)	3/8	—	—	—
Shop and shop lectures	—	13/8	22/8	41/8
Geology	6/8	—	3/8	—
Botany (?)	2/8	—	—	—
Total Related	11/8	15/8	25/8	41/8
Total direct plus one-fourth of related	10/8	5/8	17/8	16/8

Note: As the figures for the two colleges probably can not be compared directly, because of difference in matter covered under the same heading, they may perhaps be averaged thus:

Average: C.E., 14/8 } on basis of 140/8 { 10%
M.E., 11/8 } to the whole course { 8%

This list is to be read with regard to the bearing of the several subjects listed on the matter in hand. The subject "Materials of Construction" is in its entirety a part of the instruction under discussion; as ordinarily taught, we believe, it is restricted to recital of bare facts, mainly mechanical but also some of the statistical class. Work in the testing laboratory contributes sensibly to the student's acquaintance with steel and cement; its relation to timber is insignificant. On the whole it is to be credited to its full time value to the subject of materials. Shop-work adds in an important manner to the acquaintance with the three materials, cast-iron, brass and steel, but only to the value of a small fraction of the time devoted to it, since attention is concentrated on manipulation of tools and machines, and the attainment of a certain small measure of manual skill is made an object. "Shop lectures," listed for the one school, are hardly to be charged in any proportion to the subject of materials.

We may deduce from this list that in two representative institutions a total of perhaps 1¼ to 1½ hours per week is given up to instruction in Materials. This of course is a very small part of the college course. Moreover, this time is very largely devoted to but two or three materials. If the study of materials be even approximately so important a part of the student's schooling as we have endeavored to suggest, it would seem to be receiving far less than a proper share of the available time of study. We believe it is not too much to ask that this time be at least doubled, that at least one-fifth to one-sixth of the student's time be applied to the subject in question. Correspondingly, of course, it is necessary that the matter taught, and the manner of teaching, be modified to suit the larger program suggested.

Our purpose in the present article, however, is not to discuss engineering education, or suggest improvements in technical schools, but to make an argument for recognition of the important place which the knowledge of materials holds in the engineer's life. The glorification of machinery, processes and power is voiced often enough, and loudly enough, but proper appreciation of the importance of material is greatly neglected. Occasional reflection upon its real place in the engineer's work, therefore, cannot fail to be salutary.

LETTERS TO THE EDITOR.

Concrete Floor on Soft Foundation.

Sir: We are preparing plans for a factory building to be erected on a salt marsh at the edge of tidewater, and test borings show about seven feet of black mud above hardpan. Inasmuch as the requirements demand no basement in this building, our plan has been to fill the ground inside the foundation walls with cinders, gravel and other available material, thoroughly tamping same, and laying main floor of concrete on top of this.

The question has suggested itself that perhaps in severe winter weather, the freezing of this wet material under the floor could cause an upheaval of the floor by expansion. We beg to inquire whether you have any knowledge or experience in problems of this character.

Yours very truly,
Construction Company.

[We would be glad to hear from any of our readers who have had experience in this matter.—Ed.]

Adhesion and Shear Tests on Concrete Beams.

Sir: In your issue of August 15 is given the result of some tests by Prof. L. J. Johnson to determine the shearing strength of concrete and the adhesion or grip of steel rods embedded in concrete. It seems to me that Prof. Johnson's results and tentative conclusions are very misleading. Instead of showing the adhesion of steel to concrete the tests merely show the modulus of transverse strength of plain concrete that is aided somewhat by embedded steel. The loads are placed very near to the ends of the beams and do not stress the steel very much. Further, the unit stress in the concrete is not very high.

Taking the last test, which shows an apparent gripping strength on the steel of 1,367 lbs. per sq. in., the highest value found, there appears to have been a load of about 16,000 lbs. near each end of this beam at failure, and these loads appear to have been placed about 8 ins. from the end supports. These data are not recorded, but would be very useful. I have calculated the first and estimated the other. This load on a rectangular beam of plain concrete would produce 320 lbs. per sq. in. of extreme fiber stress. Why could not the concrete take all of the tension up to the point of failure and then at failure suddenly give it to the steel with the result of pulling the steel rod out? It is plain that the tensile strength of concrete complicates results in such a test. If a small wire were used for the reinforcement, the adhesive strength could have been made to appear any desired value.

It is true as a practical consideration that tensile strength in the concrete should not be computed in reinforced beams, but this does not preclude its presence in all beams properly made. One shrinkage crack at the critical section would destroy the tensile strength of the concrete for the entire beam, and shrinkage cracks are more probable of occurrence in actual structures than in test beams. This is the reason, and it is a sound one, for omitting tensile strength of concrete in calculations. It is not a fiat to annihilate tensile strength. The tensile strength is a reality, and it alters the result of tests. It also probably decreases deflection in beams.

As to the unit shearing strength found, these results are also clouded in a constrained test, as I pointed out in the case of Prof. Talbot's tests, in "Concrete Engineering," May 1 and May 15, 1907. Most reinforced concrete beams, in failing, crack in a diagonal line from a point near the support up toward the middle of the span. Call this a diagonal tension failure, or a diagonal shearing failure, or call it by any other name, it is practically a failure in shear, because it is neither a failure of the top or bottom flange of the beam but of the web. Such a failure may not let the beam down; the beam may go down because the steel rods slip out after such cracks have occurred; just as the web of a plate girder might crack and the girder be still held together by friction, finally going down because of the excessive load and local bending thrown on the flanges.

Where the edge of the load and the edge of the support are near together, the load being a rigid block, there is not the chance for this characteristic diagonal crack to develop. Furthermore, where the support is rigid and immovable laterally, a condition not found generally in practice, there is not the same tendency for this tension and shear to come into play that would exist if the supports were free to move laterally. Friction on immovable supports will take up some of the bottom flange stress, causing the beam to act partially as an arch.

Shearing strength in concrete is entirely dependent upon whether there is compression or binding stress in a direction normal to the plane of shear or tension in that direction. Rigid supports incapable of moving laterally supply the binding or compressive forces and thus obscure the results of shearing tests made with such supports. Columns and girders in actual construction do not possess lateral rigidity; rather the shrinkage is

apt to produce initial tension and create the very opposite condition from that which exists in tests.

Yours very truly,

Edward Godfrey.

Monongahela Bank Bldg., Pittsburg, Pa., Aug. 17, 1907.

Deformed Bars vs. Plain Bars in Reinforced Concrete.

Sir: I note a communication by Mr. C. H. Marquess regarding the use of hand-mixed concrete and round rods in reinforced-concrete building construction, in which he holds the recent Philadelphia failure up as an example of the danger of the use of plain reinforcement. As to the use of hand-mixed concrete, it should be avoided where practical, and generally must be avoided on account of the expense attendant upon mixing by hand where the work is of magnitude. [As stated under the heading Notes and Queries in our issue of Aug 22, the concrete in the Bridgman building was not mixed by hand but by a batch mixer.—Ed.]

As regards the use of round rods, a few facts may be of interest to your readers. In the city of Minneapolis, as far as the writer is aware, there have been no failures or collapse of reinforced-concrete construction, and not less than 90% of the work has been put in with plain round rods. Is there any other city in the United States where an equal amount of work has been done with *deformed* bars with an equally good record? In Milwaukee all the failures on record have been with deformed-bar reinforcement, while there is no case known to the writer of failure with round-rod reinforcement in the city. In the building cited by Mr. Marquess, it should be observed that expanded metal was used, a material which is so deformed as to give for its weight the greatest mechanical bond of any material on the market today, and that the round rods were used merely to supplement the expanded metal.

Is Mr. Marquess entirely justified in drawing his sweeping conclusions from the data which he presents, or would we be justified in forming the conclusion from the experience in the city of Milwaukee that deformed bars are essentially dangerous and should be barred from use?

May we not ask if the shrinkage of the concrete around the deformed bars renders them efficient just the same as it renders the round rods efficient, and if this is the case in concrete hardening in air, is not the additional cost of the deformed bars a waste of money?

The difficulty with the average advocate of the deformed bar seems to be that so much stress is placed upon the magical efficiency of the fin, corrugation, bulb, or tit on the bar that the poor devil who buys them is led to believe that this remarkable deformity will bond together properly the sand and stone in the concrete and hence there is little (if any) need of cement and proper design or workmanship, as no adhesion is required; with the natural result that 90% of the failures occur with this class of reinforcement.

This class of concrete (deficient in cement and improperly handled) may be readily dug out most any time, whether within the six months' period of Mr. Marquess or later, if it does not previously fall of its own weight. In any case it differs materially from the business-like mixture used by the successful constructor, which even at the age of three weeks invariably calls forth the most profuse profanity from the belated plumber or steamfitter who is forced to dig through it.

If the deformed bar has any material advantage, would it not seem business-like on the part of its representatives to show that it is superior to the plain bar if they can back their theoretical ideas of its superiority with test data? Let us, for example, quote the catalogue of a deformed-bar company:

> A great many formulas more or less complicated and incorrect have been devised for the computation of reinforced-concrete construction under transverse loads; the results obtained by these vary slightly, but when one considers the minimum obtainable variation in the materials used in reinforced concrete, such as stone, sand and cement, then it might be safely assumed that all formulas devised are equally correct. This point is admirably brought out by Capt. John S. Sewell, in Pros. Am. Soc. C. E., Dec. 1905.
>
> He derives the following formula:
>
> $$M = h\,d\,a\,b\,t_s$$
>
> Let us for instance take a very common type of round-rod construction shown in sketch in Engineering News of Oct. 12, 1905, p. 383, and as applied to a warehouse building in Milwaukee in the photograph, in which a panel was tested with a load of 284,000 lbs., giving a total load of 312,000 lbs., and compare the test with this formula. Some of the rods run diagonally over a span of about 24 ft., while the panel is 17 ft. × 16 ft. 8 ins. We will treat the span the 17-ft. way and figure the section of all the rods covering the panel, namely 68 ⅝-in. rounds, sectional area 7.48 sq. ins. The thickness of the slab is 8½ ins., of which part is wearing coat applied after the rough slab had been cast. Then
>
> $$d = 7.75 \text{ ins. or } \frac{7.75}{12} \text{ ft.}$$
>
> $$h = 0.85$$
> $$ab = 7.48 \text{ sq. ins.}$$
> $$t_s = 35{,}000 \text{ lbs.}$$
>
> The test load gives
>
> $$M = \text{say } \frac{Wl}{10} = \frac{312{,}000 \times 17}{10} = 530{,}000 \text{ ft.-lbs.}$$
>
> By the above formula the ultimate strength should be:
>
> $$M = \frac{7.75}{12} \times 0.85 \times 35{,}000 \times 7.48 = 144{,}000 \text{ ft.-lbs.}$$
>
> or in other words the despised round rods were carrying four times what the deformed-bar advocates figure the ultimate strength of their type and still there was no injury to the construction, and it was strained (as appears from other data) but little over half its ultimate strength.
>
> Now it would admittedly be illogical to consider the result shown as evidence that the round bar is six to eight times as effective as the deformed bar, but it is pertinent to question whether, if the advocates of this type are so lacking in general familiarity with the elementary properties of reinforced concrete as to exhibit in their formula no knowledge of questions pertaining to the economic distribution of the reinforcement, what value, if any, can be assigned to their knowledge of the advantages derived by the use of their special brand of rods?
>
> The writer has no interest whatever in any type of bar further than in questions pertaining to its economy and safety, and if he can be shown that any type of deformed bar possesses that degree of toughness and uniformity which he would demand in steel construction, together with an adequate advantage commensurate with its increased cost, he would be interested, and unquestionably influenced in writing the specifications for from 10,000 to 12,000 tons of metal for concrete work which he is called upon to do in the course of the season's work.
>
> Most, if not all, of the test data published to show the advantage of the deformed bar in point of adhesion are based on dry tamped concrete, a kind that is dangerous and unsatisfactory in practical work. Additional water in the mix with the same opportunity for the excess to work off after doing its duty in consolidating the material and furnishing the moisture for perfect crystallization would greatly change the results. Certainly the requisite amount of water in the concrete adds little to the cost, while going a long way toward securing good work, and rendering it practical to secure it under ordinary conditions. Without a wet mix, not only is the bond between the steel and concrete unsatisfactory, but also the bond or union between the portions of the work placed at different times.

C. A. P. Turner.

Phoenix Bldg., Minneapolis, Minn., Aug 19, 1907.

CONSTRUCTION OF A REINFORCED-CONCRETE FLOOR WHICH WAS TESTED WITH A SUPERIMPOSED LOAD OF 1,000 LBS. PER SQ. FT.

Some Essential Requirements in Reinforced-Concrete Work.

Sir: The apparent simplicity of the design and construction of reinforced concrete has caused to rush into the business large numbers of engineers and contractors, who have not been properly prepared, either by education or by practice. Unless legislation is speedily enacted that will protect the layman from his own ignorance, reinforced concrete will soon receive a setback that will require years to overcome.

The following points, embodied in the standard practice of the writer's organization, would have prevented all of the well-known failures of reinforced concrete in America in the last two years. They are recommended as absolutely necessary for the best results:

(1). All rods should be anchored at the ends regardless of whether or not they are deformed their entire length. If rods are ⅞-in. or less in diameter, a simple bend at right angles will be sufficient anchorage. If more than ⅞-in. in diameter, the anchor must consist of a threaded plate which is to act as a large nut on the threaded end of the rod. Aside from the question of bond stress at the end of the rod, where it is at its maximum, it is well known that the more a rod is deformed the quicker will the concrete peel off under fire.

(2). Rods should be of a cross-section that will permit the concrete to flow up under the lower side of the rod with the least resistance, and with no deformation on the rod that will tend to pocket or confine the air in such a manner as to prevent the concrete from completely surrounding and attaching itself by adhesion to the rods and thereby insuring prevention of rust and adequate fire protection.

(3). All rods in the tops of beams and girders at their supports should extend far enough beyond those points to insure sufficient anchorage even when all of the concrete below the rods in the bottom of the section has peeled off, due to the wedging action caused by the use of deformed reinforcement, or to the action of fire.

(4). Preference should be given to rods with a cross-section that will give the least wedging action to the concrete fireproofing underneath the rod when the beam is subjected simultaneously to a load overhead and a fire underneath.

(5). Rods running in the same direction should never be permitted close to each other for the reason that the spaces between them will be filled with air bubbles which will exclude a proper filling of the spaces by concrete. (While nearly all building laws relating to reinforced concrete cover this point, it is well known that this requirement, in many instances, is practically ignored.)

(6). Rods in the bottom of beams, girders and slabs should be spaced far enough apart to permit a good bond of the fireproofing concrete to the interior of the section.

(7). In no case should anything but smooth rods be used vertically. Where hooping is used in columns it should not be wired so rigidly as to prevent the concrete from settling and shrinking during its initial set. An ordinary warehouse or office building column will shrink in height from ¼-in. to 1-in. during the period of initial set, and taller columns in proportion, if filled with concrete wet enough to permit thorough ramming both inside and outside of the hooping. Unless the vertical reinforcement is smooth and the hooping not too rigid, it will disrupt the concrete during the process of shrinking. This principle is so well recognized by some engineers that they insist on very long columns being poured from a point midway their height. After the bottom portion sets the rest of the concrete is poured from the top of the column.

(8). All beams and girders should be constructed as continuous beams, even if for no other purpose than to prevent accidents through gross carelessness during construction. For instance, removing a portion of the shores too soon. This should also be done to prevent cracking over the supports due to negative moment, notwithstanding that rules and regulations for the use of reinforced concrete may require that the midsection be calculated as a simple beam.

(9). Spacers and separators of concrete should be used to space all rods from each other and from the forms. This is not only necessary from a construction standpoint, but also for prevention of damage by fire and rust. If separators are not used the rods will surely be more or less displaced by the dumping of the concrete carts and during ramming. Metal spacers and separators form a straight joint in the fireproofing and also tend to conduct heat to the rods.

(10). Forms should be as nearly watertight as possible. This means that the lumber must be sized and matched or tongued and grooved. Otherwise the cement will escape.

(11). Sand should be tested for foreign matter, for adhesion of cement, for crushing resistance and also for fire resistance.

(12) The broken stone should be tested for adhesion to cement, crushing resistance and fire resistance.

(13). The cement should be tested in accordance with the standard specifications of the American Society for

Testing Materials. Samples of actual concrete should be taken out of the wheelbarrows as they are being transported to the forms. This will furnish data, under actual working conditions, as to crushing strength, as well as the correct proportions of materials and fire resistance of the cement. In addition, the moral effect on the workmen is good and will add to the care that the man in charge of measuring cement at the mixer takes in his measuring.

(14). The reinforcement should be tested in accordance with the requirements of the American Society for Testing Materials for structural steel used in buildings.

(15). The floors must be kept covered in warm weather with wet sawdust or wet sand for three weeks, beginning 24 hours after the concrete is placed. The longer the floors can be kept wet the better the result will be. In properly designed and constructed reinforced-concrete work no expansion joints of any kind are necessary except in horizontal surfaces exposed to the sun.

(16). All forms should be pounded with a mallet while being filled. This will exclude air bubbles and make the concrete more dense as well as giving better adhesion of the cement to the surface of the reinforcement.

(17). After the forms are removed no patching or plastering should be permitted until all surfaces have been inspected, and permission given in writing by the engineer. This makes every man on the job, from the foreman down to the most unimportant laborer, more careful as to the filling of the voids in the forms. While some small patching is generally necessary, the general appearance of the surfaces that need patching is the best indication of the quality of the hidden workmanship. Great care should be taken to prevent any of the falsework dropping upon finished concrete even if it is several weeks old, as it materially injures it to do so. The less the work is jarred while removing the forms the better. The jar of a hoisting engine and concrete mixer or other moving machinery should not be allowed to reach the setting concrete.

General state or city legislation, in accordance with the practice mentioned above, and fire, water and loading tests similar to the requirements of the Building Department of the City of New York, are, in the writer's estimation, absolutely imperative.

Frank B. Gilbreth.

34 West 26th st., New York, Aug. 22, 1907.

Wealth and Wage-Earners.

Sir: Allow me to say a few words with reference to the editorial in your issue of Aug. 1 on "Wealth and Wage-Earners."

In considering the profit-bearing capital, you have neglected to include the most profitable and substantial branch of industry, namely exchange. Mercantile houses, wholesale and retail, brokerage firms, banking institutions, agencies of different kinds, etc., all reap a very rich harvest. If you take the trouble of looking into this branch, you will find that the capitalist's share of earnings is more than double the amount which you arrived at. And as the total sum of the earnings of both classes is constant, it follows that the wage-earners' share and its ratio to that of the capitalist class is much less than that given by you.

You derive your per capita rate of wages from the census figure of $840,000,000 paid out by the railroads in wages and salaries. But these also include the salaries of presidents, vice-presidents, general managers and other high officials, who are shareholders and certainly do not belong to the wage-earners' class. This correction will again reduce the wage-earners' share.

As proof of the magnitude of wealth held by the wage-earners you state that 5,690,000 families possess farms valued at $16,615,000,000. But you fail to state that the capitalist class holds mortgages on three-quarters of that amount, and, consequently the real owner of these farms is the capitalist class, and not the families who live on them.

But this is not all. What is the purchasing power of the wage-earner's share, small as that share may be? To buy his necessaries of life he has to apply to the capitalist and pay him a certain profit above the total actual cost to the latter. The manufacturer, in fixing the price of his product, adds all his items of expense: the cost of material, labor, interest on his capital, expenses of maintaining the plant, insurance, taxes, transportation, etc., and to this total he adds his profit, say 5% or 6%. Of these items, the material is not sold to him at cost. The party who sells it to him fixes his price in a way precisely similar to the one just stated. Nor is the transportation charged to him at cost. Therefore, the purchaser of the manufacturer's product actually pays the latter's interest on the capital, all his taxes, and interest on the interest and taxes, and in addition to that a substantial profit and a profit on the profit made by the owner of the material, the owner of the means of transportation, etc. Now consider through how many stages and hands the product passes on its way from the producer to the consumer. Each link of this chain of temporary owners adds his interest, taxes and profit to that of his immediate predecessor. In other words, the profit is cumulative and the profit on the profit is compounded. And the wage-earner pays it all. His wages were given to him only to look at, so to say. He eventually returns a greater part of his earnings to the employer without getting anything in exchange.

As to the aim of Socialism, it certainly is not to divide the National wealth equally between all wage-earners. This meaningless phrase has been invented by the capitalist press either in blissful ignorance, or else in order to make Socialism appear absurd. Its true aim is government ownership of natural resources, of means of production and distribution; control of production and the distribution of the product directly from the producer to the consumer. It means industrial government of the people for the people and by the people, in the same way as we think of correct political government. Socialism does not strive to destroy private property, but to protect the only private property the wage-earner possesses; that is, his labor. As to the private property of the capitalist class, you yourself have admitted that private ownership of natural resources is wrong, and you will surely agree with me that compulsory compound interest is still worse, of course for the one who has to pay it. Those who receive it will naturally be opposed to any reform which would deprive them of their gain. To them such a reform would certainly be "revolution" and contrary to the principles of "law and order" of a "civilized" community and threatening the sanctity of "private" property.

D. C. Serber, C. E.

17 Battery Place, New York, N. Y., Aug. 5, 1907.

Sir: Your editorial of Aug. 1, "Concerning Wealth and Wage Earners," was evidently written with much care, and based on considerable preparation. However, it impresses the writer with the fact that it is dangerously weak at both ends, its starting-point as well as its end-point. Permit me to explain this impression.

To begin with the end-point of the editorial. Putting your argument into a single sentence, I would read it about like this:

> The idea that capital is sharing unduly in the yield of the world's work is erroneous, because the statistics cited demonstrate that the aggregate of wages far exceeds the aggregate of "profits," or "dividends," or other capitalistic income.

It happens that the latter part of this statement can be proved as fully by more elementary considerations than the quasi-statistical which you employ. But, aside from this rather irrevelant observation, I would point to the chief weakness of the statement: namely, that the proof referred to is of no importance whatever, from the fact alone that wages and profits can by no possibility be compared. They are not coordinate, but belong in quite different categories. It is surprising, I think, that with your ready grasp of details of accounting, you should make the error of setting the two figures side by side for direct comparison.

"Labor," as you classify it, includes all of the equivalent given for "salaries and wages." What the vice-president of an insurance company draws per year as "salary" is not always, of course, remuneration for "labor." It is often determined by no natural condition, as is illustrated by the statement of one famous vice-president in acknowledging that his salary was fixed mainly by his own ideas as to what he was worth, and that he could not have obtained such a salary elsewhere. But let us say that these artificial "wages" are small in the aggregate compared to the payments to actual "labor" (which properly includes the editor and the bookkeeper as well as the dirt-shoveler). We may then take the total given for "wages" as representing the money paid to those who live by their work—those who could not live without the money which their work brings them.

I think you will admit that by far the most of a wage-earner's wages go to support him and his family. Looking at the industrial organization as a machine, and the worker as an element of that machine, the money paid to him is nearly all required for upkeep—repair, maintenance and replacement. In all other parts of this organization, the moneys necessary for upkeep and amortization are charged as an expense, not as a part of the profits. Suppose one of our industries were so organized that the workers were housed, fed, clothed, etc., at the cost of the employer, and received annually a certain "salary," a payment representing their share of the net income of the business. This sum the worker in question could save, spend or throw away. In any case it would be a net yield to him from the industry in which he works. Such a sum might more fairly be compared with the earnings of capital.

The profit or dividends or interest payments which are the returns obtained by capital are of quite another nature from wages. No upkeep, replacement or administration charges are contained in these returns. A block of capital remains intact forever, irrespective of the interest which it earns. This interest may all be utilized for purposes outside of the use of the original capital. The latter needs no food, nor clothing, and does not need to rent a house or pay street-car fares. Nor does the income of capital represent payment for the thought and attention required to make the investment or keep track of it. The income is clear "velvet." To compare such moneys with the wages paid to labor is evidently nonsensical.

When the average representative of labor has paid for food, rent, clothing, fuel, doctor's services, transportation, etc., how much of his year's receipts is left? Is one dollar out of ten left? I doubt it very much. Perhaps 50 cts. out of $10 may be assumed for purposes of argument. Then, the ten billion odd dollars you figure out will shrink to half a billion—this to be compared with 3½ billion paid for capital. Surely your ratio of 2 for labor to 1 for capital is grossly deceptive, when the true ratio can be only 1 to 7!

This deduction of yours, and several associated conclusions you draw, might be further discussed. I might raise the question what it matters how the payment to labor compares with the tribute of capital; in other words, I might ask what you have proved, if anything. But for the present purpose this is perhaps needless. I would now like to refer to the error made at the beginning of your editorial essay.

You remark on the "rapid spread of Socialistic ideas." That the study of relative returns of labor and capital is needed only in order to allay socialistic excitement, and has no other place or value, is an implied fallacy in your opening, but I take it this implication was not really intended, and lies only in the unfortunate phrasing employed. However, you clearly charge this "spread of Socialistic ideas" to the ostentation of individual instances of concentrated wealth. Do you seriously mean this? I can draw no other conclusion from your editorial.

If any of the utterances, spoken or written, of "socialists" or of other persons leaning toward "socialistic ideas" be examined, it will always be found that the denunciation is not of ostentation or display of wealth, but of corrupt use of wealth. The corrupt method of acquisition is also denounced, but this is clearly a subsequent thought. The same observation applies to the talk of the "Man in the Street." He expresses resentment first at the utilization of wealth to secure unlawful or unfair advantage, and second at the unlawful, unfair or oppressive methods by which this wealth was acquired. He may remark also on the offensive display of wealth (which is not infrequent), but this will prove to be only secondary to the previously-stated resentment. Certain it is that, whatever feelings of irritation, envy or the like may be aroused by ostentation and obtrusive luxury, they are not strong enough to carry over into the socialist camp any considerable number of followers. If many men are turning toward socialistic ideas, a fact which you premise, the conversion must be brought about by far stronger emotions. And these motive emotions are the indignation and feeling of injustice aroused mainly by the daily contemplation of wealth used to poison our public life, to defy legal enactment, to deceive or corrupt lawmakers, judges and public officials, all of which tends to defeat justice and oppress and impoverish the mass of the people. The emotions in question are also chargeable in large part to the absolute, autocratic power of various individuals and groups of men to fix prices of necessaries without regard to cost or to competition but solely with regard to their own profit.

Do you believe that a member of the "common people" is half so much wrought up over his rich neighbor's private car, or the senseless banquets he gives, as he is over the knowledge that this same neighbor has just made him pay half a cent more for each pound of sugar?

Of course, the causes which give rise to these feelings on the part of the "common people" are not connected at all with the increase of wealth as a whole, or with the ratio of capital income to labor earnings.

There are various statements in the course of your editorial which I believe lie open to more or less destructive criticism, but I shall not presume to enter into their discussion here. My purpose is merely to call attention to the state of your argument at its starting-point and at its conclusion. It appears to me that you have not stated a problem, and that your endeavor to furnish a proof of the unreasonableness of socialistic views is erroneous and abortive.

Yours truly, Old Man.

New York, Aug. 6, 1907.

Notes and Queries.

A letter signed "Civil Service Reformer," evidently designed for publication, is withheld from editorial consideration in accordance with the journalistic rule barring anonymous communciations.

Concerning the pivotal pile-driver described by Mr. R. Balfour, of Ottawa, Can., in our issue of Aug. 15, 1907, and Mr. Charles Hansel's subsequent letter (our issue of Aug. 22, 1907), stating that similar means were used previously for the same purpose (i. e., driving batter piles), Mr. Balfour writes thus:

> Since the article was written my patent solicitors have secured for me a patent on the pile-driver, but as so many of the claims which I originally applied for have been struck out, and as I have learned that many like Mr. Hansel have used a similar device, I do not now con-

sider that I have a patent of any value. But I do consider that I have evolved a principle in pile-driving which has not heretofore been used, and that is the regulation of the height of the pivoting point in the machine, so that when the leads are swung out to the line of the batter pile at the cut-off, the pile will have its proper batter, by this means avoiding the necessity of any side motion to the supporting frame.

RECENT HEAVY CRANES IN ENGLISH SHOPS.

The powerful cranes described below are illustrative of modern European practice in the design of apparatus for handling very heavy weights in shipyards and other works building heavy machinery. It is a rather interesting fact that the first two cranes were built in Germany for English firms. The builders were Bechem & Keetman, of the Duisburger Maschinenbau Actiengesellschaft, at Duisburg, Germany. The third crane was built by the Armstrong Works of England for its own use. We reproduce our illustrations and abstract our description of the first two machines from "The Engineer," of London.

TRAVELING ROTARY CANTILEVER CRANE.—The cantilever crane shown in Fig. 1 was built for the iron works and machinery plant of Markham & Co., Chesterfield, England, and is notable for the combination of movements. In the first place the machine travels along the yard on two meter-gage tracks 36 ft. c. to c., the lower portion of the tower being a heavy steel structure supported by two pairs of trucks, as shown. On this lower section of the tower is a turntable carrying the upper section, which supports the cantilever trusses for the traveling hoist. Thus the machine can travel to and fro along the rails, the load can be traversed to and fro along the cantilever, and if the load is of such dimensions that it cannot be passed through the tower, the cantilever can be swung round to deposit it at any desired point. The trucks have grooved or double-flanged wheels running on tee rails anchored to a concrete base, and they can be held by rail clamps to resist tilting when handling heavy loads. As shown in the detail of one of the trucks, the leg of the tower has a pin bearing at a point very low in the truck frame, and it is carried by equalizing levers in such a way as to distribute the load equally over the four wheels. In the two motor trucks, one of the axles is driven by gearing, and the wheels are connected by coupling rods. The traveling motor, with the reduction gears, is mounted on the platform of the lower section of the tower, and power is transmitted by shafts with bevel and spur gearing.

The revolving upper section of the tower has a central pivot, and each leg rests upon a four-wheeled truck riding on the roller path of the turntable. The revolving motor with worm-wheel reduction gear and a spur gear is placed on a bracket at the foot of one of the legs, and the driving pinion meshes with a fixed rack on the turntable. In this rack, each tooth is part of a renewable steel bolt, and while this is an expensive arrangement it provides for the rapid renewal of worn and broken teeth at comparatively small cost. A sliding coupling relieves the driving gear from jerks when the swinging motion is quickly arrested. Strong hooks engaging with the lower side of the flange of the turntable provide against tipping, by anchoring the revolving portion to the heavy traveling portion of the tower, but this upper portion has sufficient stability in itself for ordinary conditions of loading.

The track for the hoisting trolley is carried in the plane of the bottom chord of the cantilever truss, and above it is a track for a traveling counterweight attached to the trolley by a cable, so that as the trolley runs out on one arm it is balanced by the counterweight running out on the other arm. For lifting, a steel wire rope is used; this carries the load in four falls, two of which are wound round the drum. In order to hold the load, a band brake, electro-magnetically controlled, is added to the lifting mechanism. The operator's cage, on which are placed the four controllers for hoisting, traversing, revolving, and traveling, is attached to the trolley. The current conductors to the operator's switchboard and the branches from the controllers to the motors consist of bare drawn copper wires from which the current is taken by means of contacts of the wheel type.

The leading dimensions and the hoisting capacities are shown in the drawing, Fig. 1. The motors and speed capacities are as follows: (1) Hoisting; a 16.5-HP. motor, giving a speed of 30 ft. per minute for loads up to 5 tons and 10 ft. per minute for loads of 5 to 15 tons. (2) Traversing the trolley; an 8-HP. motor giving a speed of 65 ft. per minute. (3) Revolving the cantilever; a 12.5-HP. motor, giving one complete revolution in five minutes. (4) Moving the crane along the rails; a 12.5-HP. motor, giving a speed of 65 ft. per minute.

140-TON FLOATING CRANE.—This powerful machine, shown in Fig. 2, was built for the large shipbuilding works of Swan, Hunter & Wigham Richardson, at Wallsend, England, and was designed as an improvement upon the ordinary shear-legs type of hoist or derrick generally employed for handling boilers and machinery at shipbuilding yards. It has been employed in handling the machinery of the great steam-turbine steamer "Mauretania," of the Cunard Line. Its special feature is that the jib revolves in a vertical plane upon the pin bearings of the front leg of the jib. Movement is effected by long screws passing through threaded nuts at the feet of the rear legs of the jib. The jib is built up of a pair of steel trusses, an arrangement which enables it to be given a curved form like half a crescent, thus giving an overhang or reach which gives a considerable advantage over the straight legs of a shear-leg derrick. The crane has been tested with 175-ton loads, and being mounted on a self-propelling pontoon (which can be propelled either forwards or sideways) it is used in transporting machinery from the shops to the ship, instead of the bulky and unwieldy hull of the ship having to be hauled to the shops to receive the machinery from a fixed crane or shear-leg. The pontoon is 90 ft. long, and the face of the jib is set about 25 ft. back from the end of the pontoon, thus enabling large pieces to be deposited on the deck for transportation. As the crane hook can be moved only in a vertical plane a special arrangement is provided for moving the pieces or load to either side of the deck. This consists of two eight-wheel trucks running on rails laid across the deck, the trucks being operated by chains driven from one of the

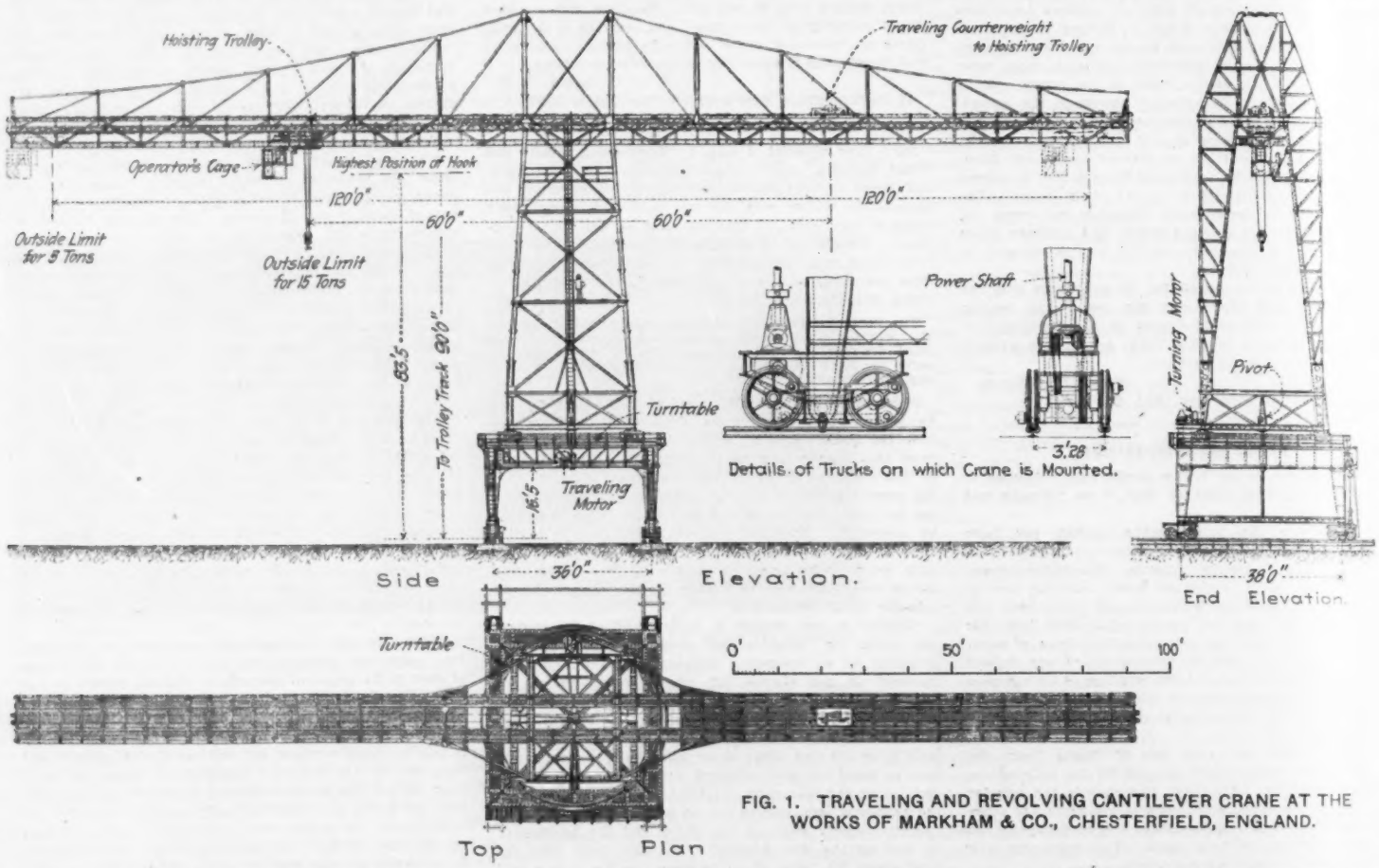

FIG. 1. TRAVELING AND REVOLVING CANTILEVER CRANE AT THE WORKS OF MARKHAM & CO., CHESTERFIELD, ENGLAND.

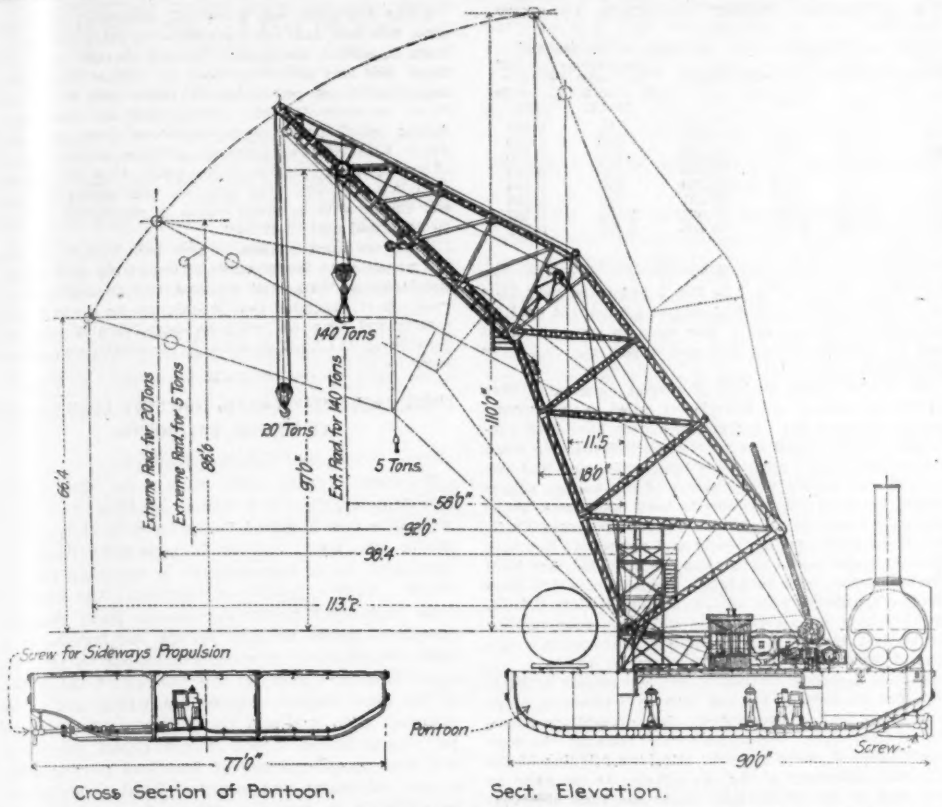

FIG. 2. 140-TON FLOATING CRANE AT THE SHIPBUILDING WORKS OF SWAN, HUNTER & WIGHAM, RICHARDSON; WALLSEND, ENGLAND.

steam capstans. The propelling engines can give the hull a speed of about six miles an hour.

The maximum reach of the jib is 80 ft. for the large 140-ton hook, and 100 ft. for the smaller 20-ton hook, these distances being measured from the middle of the hook to the turning points of the jib. The lifting gear for the larger hook is capable of carrying 80 tons at 80-ft. radius, and for the small hook 140 tons at 59-ft. radius. The smallest working radius is 9 ft. for the light lift and 16 ft. for the heavy lift. The crane is driven by a two-cylinder steam engine.

The large hook carries the loads in ten falls of rope, the small hook in four falls. The lifting ropes have a safety factor of eight to ten. The lifting gears permit of the ends of both ropes being wound up simultaneously, for which purpose the gears are provided with two separate rope drums. Both hooks have ball bearings.

The pontoon is of steel, 90 x 77 ft., and 14 ft. deep; two longitudinal bulkheads, carried the whole length of the pontoon, divide it into three compartments, and at the same time serve as crane foundations, while two transverse bulkheads divide the pontoon altogether into nine compartments, the two end series being ballast tanks.

150-TON PIER FRONT HYDRAULIC CRANE.—The huge machine shown in Fig. 3 has recently been erected by the firm of Armstrong, Whitworth & Co. at its Elswick works. It is designed for hoisting heavy loads, such as guns, armor, engines, boilers, etc., and placing them on board ships that are being fitted out; it is worked by hydraulic power, and is capable of dealing with weights up to 150 tons at a radius of 99 ft. and with lighter loads up to 25 tons at a radius of 117 ft. The range in lifting is through a height of 100 ft., and it can turn around the entire circle.

The crane is like that shown in Fig. 1, in that it has an elevated turntable on a low tower, but the tower is stationary in this case. The jib is raised or lowered to change the radius of action by a hydraulic cylinder located in an inclined position at the upper part of the post and at the back. This cylinder acts on a cross-head, coupling the inner ends of the tie-rods, and forces it downwards along inclined slides, thus raising the end of the jib. The main hoist is worked by two sets of two hydraulic cylinders so arranged that each set can be worked independently of the other, each set giving a lifting power of 75 tons, or 150 tons working together. An independent hoist is also provided for light loads up to 25 tons.

The completion of the crane was celebrated by hoisting one of the turrets for the new English battleship "Lord Nelson," a mass which looks quite insignificant in the engraving, suspended from the jib and yet weighs over 100 tons.

THE LARGE COPPER PIPE FITTINGS made by the Ford River Shipbuilding Co., of Quincy, Mass., for the turbine steamship Creole are claimed to be the largest marine copper pipe fittings made in this country. Each pipe, of peculiar skew shape, is 42 ins. in diameter and made of four sheets of 5-6 in. plate, brazed. Each fitting weighs 2,500 lbs.

WEAR AND MAINTENANCE OF STREET RAILWAY TRACK.*

By C. F. WIKE, M. Inst. C. E.†

The length of tramways at Sheffield (England) is 36 miles of route, equal to nearly 70 miles of single track, and the permanent way cost $2,211,000. The population served is approximately 450,000. The steepest gradient is about 1 in 9.5, and the sharpest curve has a radius of 38 ft. The grooved girder rails are British standard section No. 5; their length is 60 ft., and their weight 110 lbs. per yd. The older rails (as to the wear of which statistics are given) were of a different section (see Fig. 2) and weighed 108 lbs. per yd. The analysis of the rails supplied under the first contract and the present one is given below:

	First contract. Per cent.	Present contract. Per cent.
Carbon	0.35 to 0.45	0.40 to 0.50
Silicon	Not more than 0.1	Not more than 0.1
Sulphur	Not more than 0.1	Not more than 0.08
Arsenic	—	Not more than 0.08
Phosphorus	Not more than 0.06	Not more than 0.08
Copper	—	Not more than 0.08
Manganese	—	Not less than 0.70, and not more than 1.10%.
	No other material present except iron and manganese.	

The standard specification also applies to the splice-plates. Each joint is secured with six bolts and Ibbotson's lock nuts. Except where some special device is adopted, a piece of old rail about 2 ft. long, inverted, is placed under the joint and riveted to the flange of the running rail. This is shown in Fig. 1. Cross anchors are also used at 20 ft. intervals. The bonds are of the Crown solid type. The rail ends are placed close together, without any allowance for expansion. A large number of special joints have also been tried, including some which aim at perfect rigidity, others which are designed to give elasticity, welded joints, various anchors, and sleeper construction, as well as the renewable joint plates introduced by Mr. Arthur Brown, City Engineer of Nottingham.

All frogs and switches are now of manganese steel. The switch rails are 12 ft. long, and the frogs are of the "leg" type about 5 ft. to 6 ft. long. The switches are on the twin movable principle, which may add a little to the first expense, but reduces the bumping and noise as compared with dummy or open points. Renewable insets for the wearing parts have not been adopted.

The rails are laid and jointed before the concrete is laid, experience showing that by this method there is less likelihood of subsequent loosening, and the concrete is always carried over the flange of the rail. The proportions used are six of broken stone and sand to one of Portland cement, except under the rails, where one part of cement is used to five parts of broken granite and sand.

Electric traction has been in use in Sheffield for nearly eight years, the town having been one of the earliest to

*Abstract of a paper read at the annual meeting of the Association of Municipal and County Engineers at Liverpool, England, June 20 to 22, 1907.

†City Engineer, Sheffield, England.

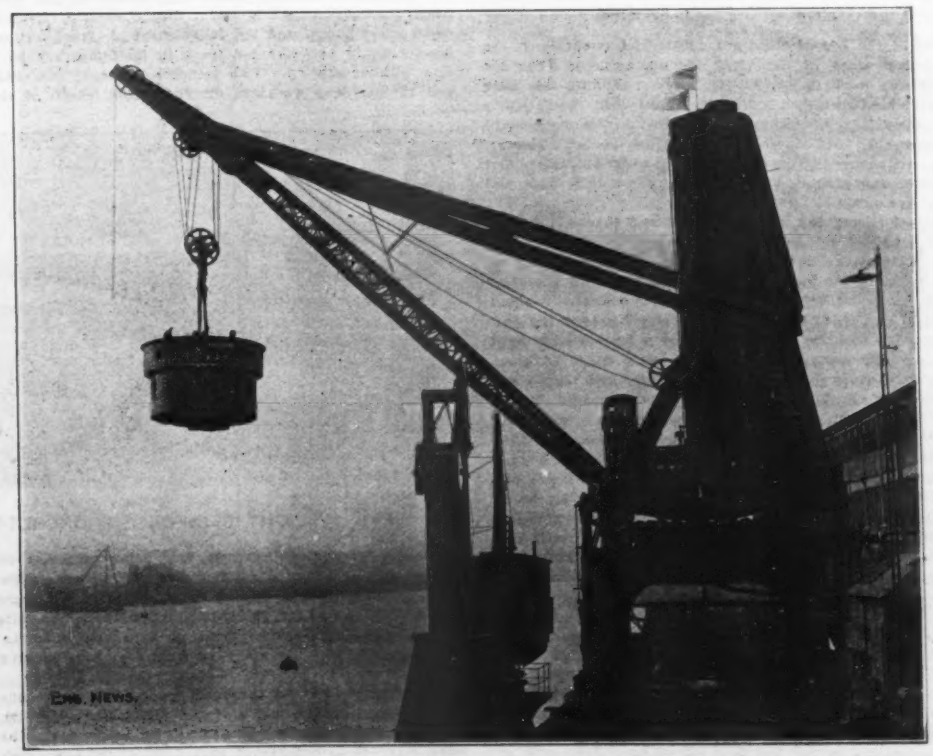

FIG. 3. 150-TON HYDRAULIC JIB CRANE AT THE ELSWICK WORKS OF ARMSTRONG, WHITWORTH & CO.

TABLE I.—COST OF REPAIRS AND RENEWALS OF THE MUNICIPAL STREET RAILWAYS AT SHEFFIELD, ENGLAND.

Year ending March.	Length of track. Miles.	Car mileage.	Car mileage per mile of single track.	Cost per mile of single track. Repairs.	Ren'wls.	Cost per car mile. Repairs.	Ren'wls.	Total.	Cost of Repairs and Renewals. Per mile of single track.	Per car mile.
						cts.	cts.			cts.
1900*	26	527,202	19,823	$1	....	0.001	....	$21	$1	0.001
1901	40	1,886,415	46,100	142	66	0.074	0.034	8,511	208	0.108
1902	50	3,525,999	70,281	303	196	0.103	0.067	25,089	499	0.170
1903	61	4,777,146	77,601	286	....	0.088	....	17,662	286	0.088
1904	66	5,768,231	86,910	645	237	0.178	0.066	58,560	882	0.244
1905	67	6,049,899	89,363	698	191	0.187	0.051	60,221	889	0.238
1906	69	6,236,561	89,980	690	403	0.149	0.132	73,021	1,153	0.281
1907	69	6,804,655	97,505	507	866	0.125	0.212	95,765	1,373	0.337

*Only seven months to March, 1900.

adopt the system, so there is a fair amount of experience available as to the cost of repairs. This cost for each year since the lines were opened is shown in the accompanying table. The sudden rise and subsequent fall in the cost of repairs is due first to the fact that some of the routes were laid with tar macadam (a form of construction known at the time to be unsuitable) which has since been replaced. Some of the earlier routes were also for economical reasons laid on old concrete foundations, and these required heavy repairs during the years 1903-4 and 1904-5. The cost of repairs is, perhaps, not of great

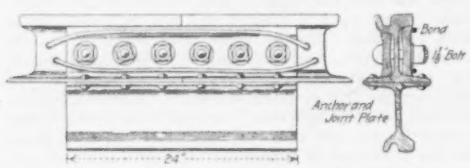

Fig. 1. Rail Joint with Anchor or Base Support; Sheffield (England) Street Railways.

value unless also accompanied by figures as to renewals, and these are also given.

The expenditure under these headings for the earlier years was trifling. Lately the figures have been increased by the conversion of tar macadam tracks to wood, which would not have been necessary had the work been carried out at first in a more permanent manner. In the eighth

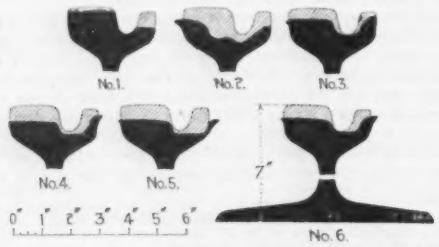

Fig. 2. Worn Rails Removed from the Street Railways at Sheffield, England.

year of the life of the lines substantial renewals in the ordinary sense of the word are commencing. Further extensive work is in view for next year, and, this door having been opened, it is difficult to tell when it will again be closed. The tendency is to make the new work more substantial; but, on the other hand (as the table shows), the frequency of the car traffic steadily increases, and heavier cars are being used, so that the annual wear and tear are greater.

In comparing the cost of repairs and renewals in different towns, not only should the age of the track and the car mileage be considered, but also the relation of the latter to the length of track. Obviously on a system with heavy traffic (in Sheffield there are annually about 100,000 car miles to each mile of single track) the cost of repairs must be greater than for a system with light traffic. The heavy gradients too are a cause of much greater expense in the matter of repairs and renewals.

However carefully statistics may be prepared it will still be impracticable to exactly compare one town with another, as each has its own peculiar features, and there is also the vehicular traffic to consider. It may be argued that the effect of such traffic on the rails is negligible, and the contention may be sound if applied to towns where there is ordinary traffic only. In many towns, however, where the loads are heavy and the traffic frequent, the cost of repairs is considerably increased in this way. The rail No. 1 in Fig. 2 had taken very little car traffic; in fact, it formed part of a track not used for any regular service, yet it was worn to such an extent that an accident was caused, and a new rail had to be substituted.

Fig. 2 also shows sections of several worn rails taken up on busy routes, and attention is called to the extraordinary effects of the wear to which they have been subjected. In most cases the groove has widened to a much greater extent than might have been anticipated, and this is attributed largely to the action of the wooden slipper brakes, the rails generally having been taken from tracks with a falling gradient. This is a proof that heavy gradients incur more cost in repairs and renewals. Not only have the brake blocks worn away the rails, but they have also forced the check outwards. The rails of which these are fair specimens were of low carbon (0.35 to 0.45%), but they have worn very evenly and given good running till the last without showing signs of corrugation. Particulars respecting each rail are given further on.

There is a certain amount of rail corrugation in Sheffield, but the trouble has not been so pronounced as in some other towns. Occasionally the corrugations disappear of themselves. When treatment is required, the most hopeful method seems to be by attaching grinding blocks to a car. Discovery of the cause seems as far away as ever, and so far no common factor has been observed. There are corrugations on rising and falling gradients, on straight tracks and curves, on loose rails and rails which are quite rigid, on welded track and track laid on sleepers; it appears in some rails after years of wear, and on others immediately they are in use, nor is it confined to high-carbon or low-carbon rails. In one case it has appeared on rails used as a temporary track, with a very flexible bed, in a few days, although such rails had been under regular and heavy traffic for eight or nine years without any sign of corrugation being noticed.

An interesting piece of renewal work is a street 1,800 ft. long, the carriageway of which has an average width of 36 ft. The daily number of car journeys over each track is approximately 1,200, and the work is being done without any suspension or curtailment of the tramway traffic. The old wood blocks having been previously moved on the night of May 24, the whole of one track (1,800 ft.) was shifted bodily 6 ft. 6 ins. out of its original position to the side of the road, and temporary connections made at either end. The operation occupied about eight hours, and the full service of cars has since been running over the old track in its temporary position without mishap. Two trenches about 18 ins. wide and 12 ins. deep were cut for the whole length of the street through the old concrete, this being necessary on account of the adoption of longitudinal supports. New 60 ft. rails with ends splayed to an angle of 45° were then placed in position on longitudinal timbers, the rails spliced, and the trenches filled in with new concrete. This was completed on June 3, or eight days after moving the old track.

In the meantime the vehicular traffic had been continued over half the width of the street until May 30, when the other track was dealt with in precisely the same way. It is anticipated that 1,800 ft. of new track will be in full use by June 12, and the remainder by June 16, or about three weeks after the commencement of the work, and that without disturbing the car traffic.

TABLE II.—PARTICULARS AS TO WORN RAILS SHOWN IN FIG. 2.

	Life months.	Cars. No.	Grade. p. ct.	Curve Rad. ft.
No. 1*	78	.....	....	....
No. 2†	92	.....	9.0	130
No. 3	93	.....	0.2	Tan
No. 4	84	2,505,208	6.6	150
No. 5	84	2,505,208	4.0	230
No. 6	84	2,134,561	4.3	Tan

*No. 1 was on a disused track, worn by vehicular traffic.
†No. 2 was the only rail on single track.

About five years ago a special junction of manganese steel was laid, and was remarkable as being perhaps the most important manganese junction carried out at the time. Not only was it intricate on account of the number of rails and points, but the shape and level made it all the more difficult. After nearly six years' wear, during which period it is calculated there have been about 6,000,000 car journeys, efficient service is still being obtained, but the parts which take the greatest wear are worn out. The junction, with additional points and curves is to be relaid (again in manganese steel) at an estimated cost of $12,000.

Engineers scarcely seem to have been as fully alive as the managers to the necessity of comparing their results, standardizing them, and utilizing one another's experience. It is suggested that if statistics as to the cost of repairs and renewals could be compiled and published, possibly on the lines of Table I., it would be an advantage.

THREE LIGHT REINFORCED-CONCRETE ARCH BRIDGES AT VENICE, CALIFORNIA.

By PAUL H. EHLERS.*

Between Venice and Playa del Rey, near Los Angeles, Cal., is a stretch of about two miles of sand a few hundred feet wide and about 15 ft. above the water. This is separated from the mainland by a lagoon over a hundred feet in width. This strip is very valuable for dwelling sites and local realty companies have recently completed three bridges across the lagoon, of a light construction peculiarly adapted to just the conditions here met. As this portion of the lagoon is the local regatta course, its width had to be spanned with a single arch, thus precluding any pile construction which would choke the channel, and considerations of cost and beauty made a steel structure undesirable. These restrictions, in addition to the corroding effects of the salt air and the destructive nature of the sea-vermin in the lagoon, made reinforced-concrete structures desirable, if not inevitable. The contract for the erection of the bridge was awarded, without competition, to the writer, who drew the designs, specifications and contracts and built the bridges, starting June, 1906, and finishing February, 1907.

The three bridges are 200 ft., 180 ft. and 150 ft. in length, respectively; the longest a highway bridge of 16-ft. clear roadway, the other two foot bridges of 8-ft. roadway. The highway bridge, illustrated in Figs. 1 to 3, consists of a central elliptical span of 96 ft., approached on each side by an unsymmetrical span of 39.5 ft. The decidedly unbalanced appearance of these smaller arches will not be noticeable when the slope fill, from the abutments towards the water, is in place. The bridge is very light but amply sufficient to carry the small loads which will come upon it. The concrete floor slab is carried, in

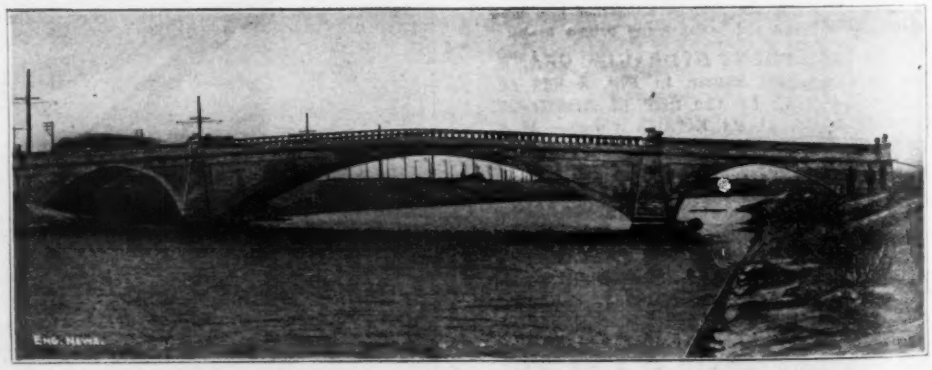

FIG. 1. LIGHT REINFORCED-CONCRETE ARCH BRIDGE NEAR VENICE, CALIFORNIA.

panels about 8 × 15 ft. in plan, upon the two face walls and one center wall longitudinally, and by the pier and abutment walls and intermediate cross walls transversely. These vertical walls rest in turn upon three arch rings. The abutments are of mass concrete, up to the water line, above which point a thin wall is carried up as a stiffener to the longitudinal walls and as a support to the floor slab and, in the abutments, as a retaining wall. The reinforcement is well shown on the drawings.

*920 Del Mar St., Pasadena, Cal.

The smaller foot bridges are of the same design as the highway bridge and have the same span center arch. The approach arches vary in each foot bridge, in one being similar to the large bridge, in the other having the small parabolic span shown in Fig. 4.

In constructing the bridges sheet pile cofferdams were driven, with piles built of three 2 × 12-in. planks. In this dam excavation was carried to about 7 ft. below high water. Wooden piles were then driven. These were plumb under the abutments and on a batter of 4 ins. to 1 ft. under the piers. The bottom of the lagoon is of gaseous blue marsh with mats of sea-weed and subterranean streams of water at intervals, so some of the piles drove very hard and others dropped half their length under their own weight. Temporary piles were then driven to high water line in bents 10 ft. c. to c. for the entire length of each bridge, and upon these piles falsework for centering was erected. The structure was erected as a monolith up to the railing, which was constructed of separately molded slabs and balusters.

On account of the San Francisco disaster, which occurred just about the time the designs were submitted, prices were abnormally high. A thousand barrels of cement were used at nearly $4.50 per bbl., about 50,000 ft. of lumber were used, averaging $26 per M. Fortunately, the tide helped to equalize things by washing up at times good sand and gravel at points within a few miles of the work; this gravel averaged 90 cts. per cu. yd. About twenty tons of steel were used at $46 per ton. The cost of pile-driving was $3,600; the cost of erecting the framework of the highway bridge was $300, and of placing the steel in the same bridge, $200. Concrete was mixed by machine, one part cement to five parts of ocean gravel, and placed for about $1 per cu. yd. The dozen molds used for casting the balusters were made of plaster of Paris, using a wooden baluster to make the molds. The balusters required but little dressing, about 99% of them being perfect; they cost about 60 cts. each. The urns and festoons were patterned of blue clay, from the lagoon, and the molds made of plaster of Paris. The urns were reinforced with steel wire, and cost about $10 each. The lumber was used three times, after each using it was scraped and all the nails were drawn; after completing the bridges the lumber was again scraped, and sold for $15 per M. The three bridges cost the company a total of $18,578.

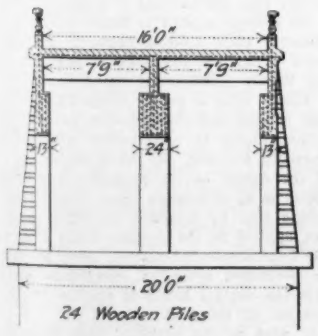

Fig. 3. Cross-Section at Haunch.

THE USE AND THE ABUSE OF SEWAGE PURIFICATION PLANTS.*

By A. ELLIOTT KIMBERLY.†

Shortly after the introduction of the water carriage system of sewerage in 1855 (1), it began to be recognized that the withdrawal of the liquid wastes of the community from the immediate neighborhood of the city or town did not entirely effect their satisfactory disposal, especially where such communities were located on the banks of streams of small flow subject to summer drought. A dilution of from 36 to 45 to 1, such as is usually considered to be sufficient to prevent putrefaction on the part of mixed sewage and river water (2), is usually obtainable only in the case of cities or towns situated on the shores of the larger rivers, hence in other cases the problem of the purification of sewage presents itself for consideration.

As is well known, the extent to which it is necessary to carry the purification of domestic sewage is governed largely by local conditions. By this is meant that according to circumstances of flow of a stream, the character of its waters and their subsequent use as a source of water supply, the needed degree of purification of the sewage discharged into the stream may vary within wide limits. Aside from the discharge of sewage into the sea, where after rough screening, putrefaction is overcome by processes of dilution, the needed degree of purification of domestic sewage may be said to be governed by three general rules. These are as follows:

(1) Where the sewage effluent is to be discharged into running streams subject to floods and with a water containing considerable turbidity at all seasons of the year, the degree of purity required need not be more than that of an effluent which undiluted will no longer putrefy under summer conditions.

(2) In streams the waters of which are clear except at times of flood, the purification of the sewage should be such as to remove from it the largest practicable quantity of suspended matter, so that the visible purity of the stream will not be affected, the non-putrefaction of the effluent being taken as coincident with a degree of purification which will afford an absence of all but small amounts of turbidity.

(3) In drinking water streams, and in certain cases of sea discharge where shell fish layings must be protected from contamination, the purification of the sewage must needs be carried out to its fullest extent, and besides the production of a chemically stable effluent, the problem practically reduces itself to the destruction of all the disease-producing bacteria present in the raw sewage, by subjecting the well purified effluent to some form of sterilization process.

The conditions referred to in the first instance are such as obtain quite generally in Ohio and the middle West. In practically all of the plants in operation in this state, the attainment at all times of a non-putrescible effluent would satisfactorily accomplish the purpose for which the sewage plant was installed. That is to say, in this section of the country, where the glacial drift formation is absent and where abound clayey soils subject to easy erosion, practically all streams are muddy throughout the year and except in a few cases where there is involved the protection of a water supply, the abatement of a nuisance from the discharge of sewage into small streams with but low dilution is readily effected by processes of purification depending upon the use of filters of coarse material operated at fairly high rates and yielding effluents, which, when clarified by subsidiary subsidence, mixed with river water, successfully pass tests for ultimate stability.

In cases where streams are of low turbidity except in flood stages, processes of sewage purification looking merely to the ultimate stability of the effluents therefrom, owing to the suspended matters incidental to their effluents, will tend to impair the general appearance of the stream, and in these, advantage must be taken of types of purification processes involving the use of materials of fine grain and operated at comparatively low rates. Such conditions are generally found in New England and in some of the states upon the Atlantic coast line, where fortunately sandy areas of suitable size and character are usually available, and under proper supervision and intelligent management, the use of these areas produces effluents of a high degree of purity containing but small amounts of suspended matters for the greater part of the year.

In streams used subsequently as a source of water supply, the discharge of sewage therein must be prevented whenever possible. Many instances are to be found, however, of sewage discharge under such conditions as the above, and hence there becomes necessary a form of sewage treatment that not only will prevent what may be called the chemical pollution of the stream, but such as will destroy all bacteria of pathogenic origin as well. As yet, but little practical knowledge has been developed in this country as to the practicability of destroying the bacteria of disease which the most thorough practical sewage treatment fails to remove. Considerable recent

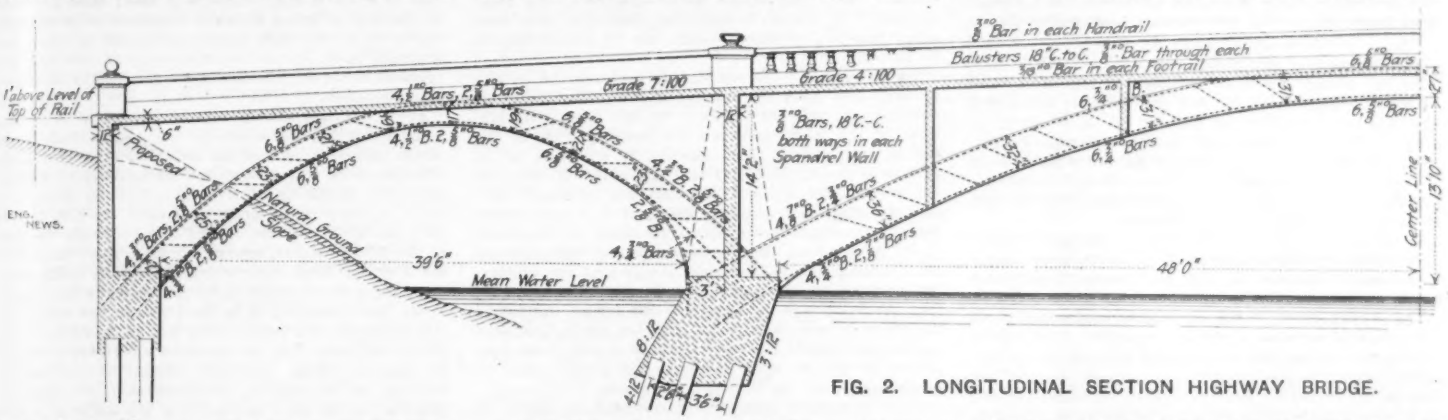

FIG. 2. LONGITUDINAL SECTION HIGHWAY BRIDGE.

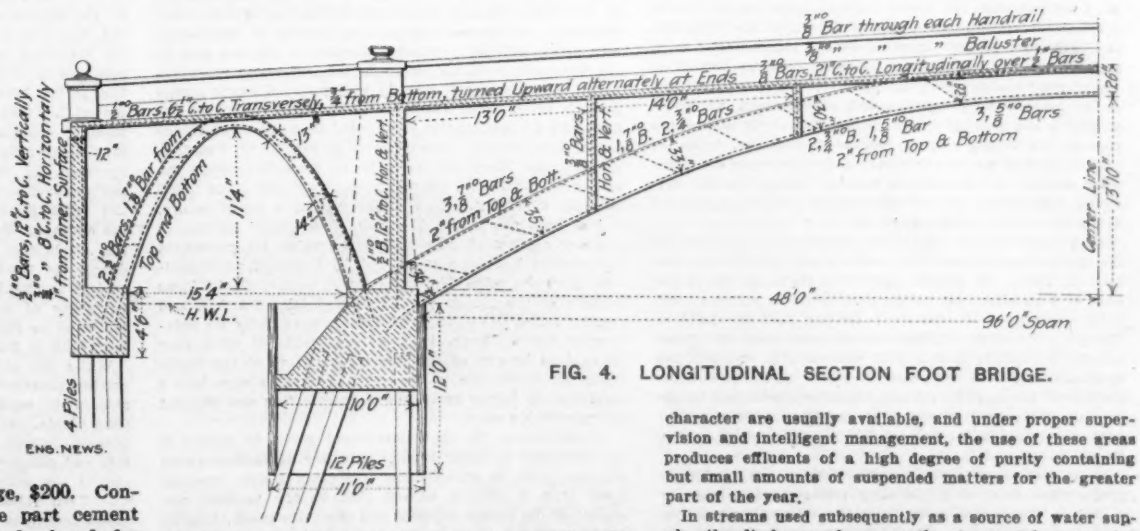

FIG. 4. LONGITUDINAL SECTION FOOT BRIDGE.

*Slightly condensed from a paper read before the Ohio Engineering Society, 1907.

†Special Assistant Engineer, Ohio State Board of Health, Columbus, Ohio.

work, however, has been done along this line in England (3) (4) and in the United States (5) and experiments have been conducted in several places in this country looking to a solution of this phase of the sewage problem (6) (7) (8). A number of disinfectants have been tried thus far, chief of which may be mentioned: Lime, acids, ozone, permanganate chlorine as bleaching powder and also produced electrolytically, and copper sulphate.

Data are yet too meager to enable conclusions to be drawn as to the practicability of the disinfection of sewage effluents, in part as to most efficient reagent to be employed, and in part on the grounds of cost, but with the accumulation of evidence from experiments carried out up to the present time it appears to be quite generally recognized that the day is not far distant when drinking water streams will be rendered freer from pollution by sewage bacteria of disease origin by the use of sterilizing agents, before the sewage effluent carried to a non-putrescible state by a modern process of sewage purification shall be allowed admission into a stream used below the outfall for domestic consumption.

SEWAGE PLANTS IN OHIO.

The members of this society are more or less familiar with the sewage plants in operation in this state from personal acquaintance and from the excellent account of the Ohio plants prepared in 1903, by Mr. R. W. Pratt, C. E. (9). On this account and with the thought of localizing the discussion, the subject in hand will be confined to the plants in operation in this state, although the remarks as to the neglect of sewage plants may be said to have a somewhat general application.

At the present time the Ohio plants comprise 18 municipal, town or village plants and 19 institutional plants; 7 are under construction and the number of proposed plants appears steadily to increase.

The sewage plants in this state embrace practically all the principal methods of sewage treatment, from simple clarification by the use of chemicals followed by settling tanks (chemical precipitation), a practice followed so largely in the earlier days of sewage treatment, to the modern continuous filter composed of particles of coarse grain and operated with settled sewages at high rates of filtration per acre. In fact, within about a year, the city of Columbus will be treating its sewage in a plant which represents the most advanced type of sewage purification plant, wherein the screened sewage, settled in septic tanks, will be applied to filters of coarse grain material 5 ft. in depth, the application of the sewage being effected by means of nozzles operating under a head of about 5 ft. causing the sewage to reach the filters in a spray or in fine drops similar in effect to the action of lawn sprinklers. The Columbus plant when completed will be the largest of its type in operation in this country, as it will comprise septic tanks of 8,000,000 gals. capacity, ten acres of filters and subsidiary settling tanks of 4,000,000 gals. capacity, the ultimate capacity of the design being 20,000,000 gals. (10).

GENERAL EFFICIENCY OF OHIO SEWAGE PURIFICATION PLANTS.

In view of the great variety of sewage purification treatments carried out in this state, it is not surprising that the degree of purification obtained varies within very wide limits.

Excellent results are being obtained by the intermittent filtration process in cases where the material is of suitable grade, the quantity of sewage to be treated is not excessive and where the supervision is such that the filters receive the proper amount of attention, by which is meant the raking of the surface material, the operation of the filters upon a strictly intermittent basis, in the absence of automatic flooding devices, and the thorough cleaning of the filters in case there develops evidence of ponding due to over-dosing or to clogging on the part of the surface layers.

As a general rule, the filters composed of material of fine grain now in operation in Ohio may be said successfully to purify the sewage applied to them, except in the case of a number that need enlargement or to which but little attention has been paid on the part of those in charge. The clear cut effluent obtained from the intermittent sand filter is met with occasionally, but requires optimum conditions with respect to the quantity and the quality of the applied sewage, rigid intermittence in the flooding and careful attention to the filter surfaces to ensure the ready admission of the oxygen essential to a maximum of oxidation.

In a number of plants constructed in the last eight years, some form of preparatory treatment has been included in the design aside from the older chemical precipitation processes. Chief of these processes is the treatment of the crude sewage by sedimentation in septic tanks, wherein there is effected a removal of about 50% of the suspended matter of the crude sewage with the resulting liquifaction of from 25 to 50% of the deposited sludge. At the present time there are 15 septic tanks in operation in this state; of this number, 12 are covered, and 3 are open tanks.

The general appearance of the different septic tanks varies greatly. Of those mentioned above, some appear to destroy sludge readily, while in others the accumulation of sludge is quite rapid. The presence or absence of scum on a septic tank is somewhat difficult to foretell as it seems to be dependent upon several conditions, chief of which perhaps is the relative strength of the sewage, dependent on the per capita sewage flow. With a small per capita flow, sewage tends to possess a turbid milky appearance, is strong-smelling after but short storage and contains a relatively large proportion of colloidal suspended matters. Highly diluted sewage, especially where large amounts of surface water are included, generally carries suspended matters of a flocculent character, capable of rapid subsidence under a reduced velocity and at times carries a small amount of dissolved oxygen through the septic tank. Broadly speaking, sewages may be separated into the above two classes, the division between which is rather indefinite. From the observation and the experience of the speaker, however, it has been noted in many instances that scum formation and highly concentrated sewage are in some way intimately related, as in the case of tanks treating weak sewages, the rising sludge forced upward by the gases incidental to sludge fermentation generally falls back again before a permanent scum has an opportunity to be formed.

The efficiency of the septic tank may now be said to be dependent upon the relative quantity of suspended matters that may be removed by the tank, the older view of the modification of the liquid portion of the sewage itself having been disproved by a number of instances in recent years (11) (12) (13) (14). Without the aid of chemical analysis and carefully averaged samples extending over a considerable period, it is of course difficult to judge of the actual efficiency of the septic tank. At the same time, from the general appearance of the oxidizing devices and from the fact of the successful operation of the plant at rates considerably higher than would be possible were the raw sewage applied to the filters, it will be apparent that the septic tank as a preparatory process for the removal of a part of the suspended matters in many instances has proven itself an important factor in sewage purification.

There is another side of the treatment of sewage in septic tanks that deserves considerable attention, namely the disposal of the residue from the hydrolysis of the sludge. The first advocates of the septic process were firm in their convictions that at last there had been devised a process for sewage treatment that would effectually solve *the problem* of the sewage problem, *the disposal of the sludge*. Many statements were made and many views were expressed that a septic tank when installed would never require cleaning; that in some manner not clearly understood it was capable of destroying the sewage solids to be subsequently applied to it. Such views are now known to be untenable. While the process does effect the destruction of a certain proportion of the deposited suspended matters, yet there always remains an ever-accumulating quantity of sludge which in course of time requires removal, in fact in the most modern designs sludge areas are provided for the cleaning of the tanks.

Considerable experience has been gained relative to the cleaning of septic tanks and the undertaking is not generally considered to be attended with the production of a nuisance, as might be supposed. In fact the removal of the sludge from a septic tank which has been in service for a considerable period may readily be handled at any plant without particular discomfort on the part of the workmen or of the people in the immediate neighborhood. The absence of odor in well-matured septic sludge is such as to cause considerable comment when for the first time an opportunity is afforded to witness the cleaning of a septic tank. As reported by Mr. R. W. Pratt, C. E. (15), the Mansfield septic tanks were cleaned in the spring of 1906. In all there was removed about 1,200 cu. yds. of sludge. This sludge was of a pasty nature, it had been compacted during its four years' storage to a water content of only 82%, and further its putrescent components had been so altered by bacterial decomposition that the wind blowing over a comparatively large surface of the sludge ponded to a depth of a foot and freshly deposited, brought therefrom practically no noteworthy odors. Such, then, is the result of what may be said to be one of the important offices of the septic tank, the conversion of the non-hydrolized sludge into a residuum no longer amenable to putrefaction and without an appreciable odor.

In addition to the above-mentioned points in regard to the efficiency of septic tanks, there is still another phase of this form of preparatory treatment which deserves more than a passing notice; that is, the periodic upheaval of the sludge deposits and the consequent clogging of the oxidizing units by the suspended matters thus carried onto the surface material. It is a well-known fact that there are periods in the operation of a septic tank usually subject to continuous quiet ebullition of gases, and with a relatively high subsidence efficiency, when of a sudden there rises to the surface of the sewage large masses of undigested suspended matters borne upward by the sudden release of a comparatively large quantity of gas confined under perhaps a heavy deposit of sludge. At such times the suspended matters in the effluent increase abnormally and tend to choke the pores of the filters, and in certain cases cause the production of decided odors in and about the tank and the plant. This feature of the periodic upheavals in septic tanks is many ways is, of course, a marked detriment to the process, owing to the load of finely divided suspended matters that are forced upon the oxidizing devices; it is, however, a condition which may be considered as inevitable in the case of most sewages and to a certain degree would be desirable to provide means to prevent the damage which is caused by the sudden discharge of suspended matters in such large quantities. Generally, aside from surface baffles located near the outlet end of the tank, these being intended to cause the sewage in discharging to pass out with a minimum of disturbance, no especial devices have been employed to reduce the suspended matters at the periods of unusually violent septic activity, and the effluent heavily charged with suspended matters passes on to the filters. At such periods filters of fine grain require especial care in their operation, and, unfortunately for the general efficiency of the plants, the lack of attention they receive is in many cases deplorable. In the case of strong sewages it appears to be a difficult matter to control these fomenting periods in septic tanks although tanks on the compartment plan (16) and those operated in series (17) may quite possibly be effective in some instances.

About the time sudden impetus was given to the construction of sewage plants by the rise in favor of the septic tank as a part of the design of such plants, considerable work was carried out, particularly in England, as to the feasibility of treating sewage in filters composed of fairly coarse-grain material. The first of these were operated upon the contact plan, wherein the outlet of the filter is closed, sewage admitted until the pores of the filter are filled, after which the sewage is allowed to stand for a stated period in contact with the filtering material, thus subjecting it to the action of the bacteria retained thereon. The contact filter will be recalled as a type of filter resulting from the increased knowledge of the bacteriology of sewage treatment brought forward particularly as, by its adoption, the purification of sewage was hoped to be the more economically accomplished in cases where fine grain material was scarce and where a limited area was available as a site for the sewage plant. As the head required for the operation of a sewage plant involving contact filters is less than that necessary for the most recent development—the sprinkling filter—there are many cases where the installation of a contact filter plant may successfully solve the problem of sewage purification, especially where sand filtration is impracticable.

The plants operated on the contact principle in Ohio number eight, and in each case the sewage is subjected to some form of preparatory treatment before being oxidized in the filters. The efficiency of these plants varies considerably. In some instances the resulting effluents are carried to the non-putrescible stage as a result of the preparatory and the oxidizing treatment, while in others, the effluents of the contact filters possess considerable odor, are free from dissolved oxygen and protecting nitrates, and do not successfully pass tests for putrescibility.

In the majority of cases the effluents as discharged are low in suspended matters and hence of good appearance. This feature of the retention of the suspended matters of the applied sewage is characteristic of the contact filter, and it is evident that the amount of suspended matter contained in the sewage applied to filters of this type controls in a measure their holding capacity and thus the period between obligatory cleanings of the filtering material. Owing to the detrimental effect caused by flooding contact filters with a poorly prepared sewage, that is, an influent of high suspended matter content, the operation of contact filters in conjunction with septic tanks should be carefully watched. By taking advantage of the flexibility of the design of the preparatory devices, the endeavor should be so to operate them, that, changing conditions being met by modified operating procedures, the sewage applied to the contact filters may be as free as possible from suspended matter, never showing evidences of too prolonged retention, conditions which will tend to enable the contact filters to operate at their best with a minimum of clogging.

While the sandy area or the artificial sand filter receiving practically crude sewage or that treated by subsidence in septic tanks, are chiefly represented among Ohio plants, yet there are certain cases where a finishing process follows the oxidizing treatment, by which are obtained effluents of considerable purity, generally stable and of low suspended matter content.

THE NEGLECT OF THE SEWAGE PLANT.

The failure of the sewage plants at present in operation is due in many instances to the lack of careful supervision, to the utter disregard of the principles underlying the successful prevention of a nuisance by the use of the sewage plant, to exceeded capacity and at times to faulty design. The types of sewage plants represented by those just reviewed depend for their success upon the manner in which they are operated.

The idea that the construction of a sewage plant ends the matter, in so far as relates to those responsible for its construction, is clearly false to the extreme. New conditions are constantly arising, brought about, if you

will, b the ever-increasing volume and strength of the sewage due to new connections, especially in towns recently sewered, and to meet such changed and ever-changing conditions means should be provided for the due care and attention of the sewage plant at all times. In planning the purification of the sewage of a city or town questions of economy at times demand that the areas initially provided shall be limited to such as will effectively handle the estimated sewage flow for the immediate needs of the community, together with slight additions amounts to provide for future growth. In addition to the quantity of sewage provided for by the design, the flexibility of the design should be such that additions to the plant may readily be made when the future demands upon the plant require such extensions. As the period of service of the sewage plant increases and as the adoption of the water carriage system of sewage becomes more general in a community, the sewage plant, in many instances subject to but scant attention, becomes so overburdened by the largely increased volume of sewage reaching it daily that under the best of supervision and management it will not be adequate to meet the increased volume of sewage flow. There appears to be but little attention paid to this side of the sewage purification question and as a result there are to be noted a number of plants which are fast approaching the nuisancce stage. The needed increase in the area of a sewage plant commensurate with the increased number of connections with the sewerage system brings up the further point that before drawing definite conclusions as to the problem of the sewerage of a city or town, in cases where disposal by dilution may serve for a time to prevent nuisance, the details of the sewerage system should be such that a sewage purification plant may be installed without undue cost when dilution facilities become inadequate with the increased use of the sewers.

With the installation of an automatic device, the idea seems to have become fixed in the minds of some that such devices eliminate for all time the necessity for all supervision, and at times plants so equipped are to be found in a state of sad neglect. Not alone do the filters themselves suffer from this lack of care and attention, but the dosing or discharging apparatus itself has gradually deteriorated, its moving parts have become rusty for want of oil, with a final result that the feature of automatic operation has to be abandoned and the plant is then hand-operated with enforced supervision, oftentimes but little more systematic than obtained during the life of the automatic appliances.

In the case of plants operated on the intermittent basis, it is apparent that considerable care is necessary to keep the surface material porous and free from vegetation, in this way overcoming the deterioration of the effluent resulting from the inability to operate the filters intermittently. The cost of maintenance for sewage plants is not as great as might first appear and surely by due regard to the condition of the plant at comparatively frequent intervals, thereby insuring its high efficiency at all times, there will be entailed less cost in the long run than the extensive repairs, weed cutting, grubbing, plowing, etc., eventually necessary when plants have been utterly neglected for long periods.

For the protection of the waters of this ever-growing country there is a need for the purification of all sewage within a given drainage area. With a sewage plant ready for service, every effort should be made to operate it to the best advantage. Unless the results obtained from sewage plants under practical operation are such as to be considered reliable indications of the merits of a given design, future progress in the art of sewage purication has apparently received a serious setback. It may not be too strong a statement to make that the weak side of the present status of sewage purification is the fact that after the plant is designed its efficient operation is so rarely assured that no opportunity is afforded the engineer to follow up his work, to study the efficiency of his design upon a practical scale and to add to the progress of the art of sewage purification by the modification of future designs according to the experience gained from the operation of plants designed according to older standards. A neglected sewage plant can hardly be counted upon to afford much reliable information along the above-mentioned lines, hence it is apparent how urgently necessary is a radical improvement in the handling of sewage purification plants.

The need for the expert supervision of the sewage plant, especially in the early history of its service, is well expressed by Alvord (18) in a paper read before the Western Society of Engineers, several years ago. He says:

> The termination of the expert supervision of sewage purification plants usually takes place a few weeks after their completion. The engineer who had their inception and formation, and who has studied every phase of their environment, who knows what kind of sewage is to be dealt with and its quantity and variations, who understands how such variations are to be met, and who will be equal to any emergencies, drops out, is paid off, and the plant is turned over to the tender mercies of a place-hunter, perhaps, or is forced on the unwilling care of some city official with other duties which already fill his time. This is wrong, and to this condition can be traced many cases of dissatisfaction on all sides. The engineer who has carefully designed and constructed a sewage disposal plant should be retained to supervise its operation for at least a year after it is started. He is the one of all others who can successfully launch it on a successful career, and meet the problems of control.

Another phase of the neglect of the sewage plant is the indifference exhibited by officials. The sewage plant is not a revenue producer, it was installed in many cases as a result of suit, it will probably reflect no special credit on the political administration, hence a tendency to cut to a minimum charges for operating expenses, to allow it to pass into oblivion. As the sewage plant represents so much of the city's invested capital, why is it not to be considered as such, and dealt with accordingly? For an equal investment in a private enterprise, not only would care and attention be paid to its management, not only would systematic daily records be kept of the features of its operation, but there would also be provided a sinking fund for its subsequent renewal. How different are the facts in the case of many of the sewage plants. Such instances serve to show the necessity for a strong effort to improve present conditions, and all in any way associated with sewage purification plants should take advantage of every opportunity to place the practical side of the purification of sewage on a better footing.

In these days of the rapid advance of sanitary science, it is signally fortunate that by recent Ohio legislation there has been provided a means whereby attention may be called to the neglected sewage plant and whereby opportunities may be afforded for closer study of the sewage problem upon a practical basis, with the endeavor to raise the operating standards of all sewage plants that they may effectively solve the problems of sewage purification. [See Eng. News, June 20, 1907.]

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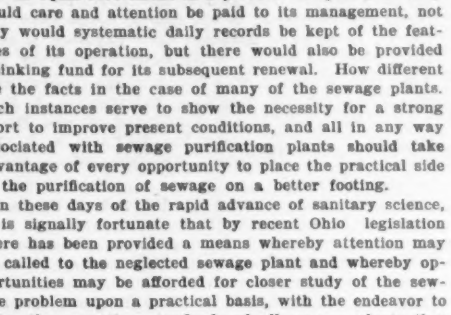
A FLANGE UNION JOINT WITHOUT A GASKET.

A novel self-seating brass and malleable iron pipe joint has been placed upon the market. It employs of heavy flange union without the use of a gasket. As one end has a loose collar the bolts may be made to match the bolt holes in any position. This union is not intended as a swivel joint, but the ball seat is provided to allow considerable disalinement of pipe without spoiling a tight joint. The joint is made of malleable iron, except the seat, which is of brass. Thus, the actual seating of the joint is between a hard and a soft metal. The Kewanee flange union is manufactured by the Western Tube Co., of Kewanee, Ill.



A Flange Union Joint Without a Gasket.

TEN PERSONS WERE KILLED and 25 injured near Coutras, France, on Aug. 25, when the Bordeaux-Paris express collided head-on with a freight train. A misplaced switch is the reported cause of the accident.

A HEAD-ON COLLISION between two passenger trains on the St. Louis & San Francisco R. R. at Sapulpa, I. T., killed four and injured 30 persons on Aug. 24. A dispatcher's error in issuing train-orders is reported to have been the cause.

A CAVE-IN occurred on Aug. 22 in No. 14 Colliery of the Erie Coal Co., at Port Blanchard, Pa., near Pittston. Five men were caught, and while one was rescued the other four were still buried at latest reports. A "squeeze" had been in progress for several days, and the workings had at once been shut down; the men caught were timbermen who were attempting to check it.

THREE SERIOUS EXPLOSIONS of stationary boilers are reported this week: At Pondsville, near Hagerstown, Md., three men were instantly killed on Aug. 26 by the explosion of a sawmill boiler; the boiler shell was thrown 200 ft. At Scranton, Pa., a boiler in Robbins & Spencer's feed and flour mill blew up on the same day, wrecking the mill, injuring seven, and causing a loss—including that to Armour & Co.'s plant adjoining, which burned—of $85,000. In the hold of the barge "Paterson," lying at the foot of Seventeenth St., Hoboken, N. J., the boiler of a donkey engine exploded on Aug. 23, instantly killing six out of seven men in the hold.

A DYNAMITE EXPLOSION IN THE FANGTSE mine, of the Shantung Mining Co., in China, was reported on Aug. 20. Two white men and 110 Chinamen were reported killed.

BURNING OF THE ROUNDHOUSE of the Buffalo, Rochester & Pittsburg R. R., at Rochester, on Aug. 24, destroyed 14 locomotives and caused an estimated loss of $150,000. Explosion of a crude-oil machine, used in firing up engines, caused the fire.

A CHANGE IN THE RUNNING TRACKS for incoming and outgoing trains to and from the Grand Central Station, New York City, was made on Aug. 25 by the New York Central and the New York, New Haven & Hartford Railroads. Since 1886, to facilitate terminal arrangements, the incoming trains have taken the left-hand track and the outgoing the right-hand. These roads were the only ones in the country to follow that plan. When it was decided to make the change to the more conventional method, employees were instructed carefully by lectures, and by drill with a special train, in the new signaling involved. Sunday was selected for the change as being a day of light traffic, but, contrary to expectations, it proved one of heavy travel. Some confusion and delay of trains, resulted on both roads in consequence.

THE CONTRACT FOR PRELIMINARY FILTERS at the Torresdale filtration plant, Philadelphia, has been awarded to the Millard Construction Co., which is virtually Mr. James P. McNichol, who, under the name of the D. J. McNichol Co., held several of the filtration contracts annulled some two years ago. The contract price is computed as $1,156,411, or only $348 lower than the Mack Paving Co. The McNichol bid became the lowest by choosing between offers for different ways of executing two items of work called for in the specifications. That is to say, bids were invited on three different styles of device for controlling the rate of filtration, and of these three the city chose the highest priced one, which happened to be the one in which Mr. McNichol came nearest to the bid of the Mack Co.; the city also submitted its own specifications for gages, and at the same time permitted the contractor to put in an alternative bid on gages to be furnished in accordance with his own specifications. The McNichol bid on gages, according to the McNichol specification, was sufficiently lower than the similar Mack bid to overcome by $348 the $4,661 of excess price of the controllers of the McNichol bid.

THE CONTRACT FOR THE ASHOKAN RESERVOIR dams has been awarded to the MacArthur Bros. Co. and the Winston Co. at their joint bid of $12,669,775. The four other bids, with some of the detail prices, were given on page 175 of our issue of Aug. 15. The lowest bidder was the John Peirce Co. ($10,315,350), a well-known New York contracting firm, which built the new Hall of Records, New York City. The three members of the Board of Water Supply, Messrs. J. Edward Simmons, Charles N. Chadwick and Charles A. Shaw, have issued a statement giving their reason for not awarding the contract to the lowest bidder. After speaking of the expert knowledge and experience required in the construction of dams, the Commissioners state:

> The cost of the work, as separately and independently estimated by the chief engineer, two designing engineers and an assistant engineer, is shown to be over $2,000,000 more than the bid of the lowest bidder. These estimates of the engineering department are confirmed by the bids of four of the five bidders, each one of whom has had more or less experience in this particular kind of work. In an analysis of the bid of the lowest bidder his figures on masonry work, with which he is familiar,

are approximately correct, according to the best evidence obtainable, but in the items of excavation and embankment his figures are over $2,000,000 less than the next lowest bidder.

In regard to their bid, Mr. Peirce, of the John Peirce Co., the lowest bidder, states that in the matter of excavation and embankment for reservoir construction his company has had no experience; that they were dependent upon others for their figures; that upon investigation he can procure no figures on these items to protect their proposal, and that upon rechecking his figures he finds that the estimate is too low to do satisfactory work for himself or the city. Therefore, the estimate of the engineering department and four bidders out of five is practically confirmed by the statement of Mr. Peirce himself, and there is no other conclusion to be reached, in the light of this evidence, than that the bid of the lowest bidder is much below the necessary cost, besides being concededly based upon lack of knowledge and experience as to excavation and embankment items.

To best secure the efficient performance of this work it is necessary that the Board of Water Supply should take into consideration every phase of the question, the elements of which are financial standing, knowledge, experience, and such a margin for profit as will secure willingness and ability to continue the work to its conclusion with essential speed, the absence of any one or more of these elements being vital. Therefore, in the case of the lowest bidder the absence of the elements of knowledge and experience in the matters of excavation and embankment for reservoir construction, and the evidence showing lack of margin for legitimate profit, is deemed sufficient, in the interests of the city, to recommend the rejection of that bid.

The Commissioners also state that their decision not to award the contract to the lowest bidder was in accordance with the opinions of Mr. J. Waldo Smith, M. Am. Soc. C. E., Chief Engineer of the Board of Water Supply, and Messrs. John R. Freeman, William H. Burr and F. P. Stearns, M.'s Am. Soc. C. E., Consulting Engineers to the Board. It may be added that many millions of cubic yards of excavation and embankment are involved in the contract, and that on very large quantities of this class of work the price named by the lowest bidder was only a little more than half that named by the successful contractors.

DREDGING WAS BEGUN on Aug. 22 on a deep-water channel through Newark Bay and the Passaic River, N. J., 11 miles in length, and with a minimum depth of 16 ft. at low tide. This will enable ocean-going vessels to reach Newark, for at high tide there will be from 20 to 21 ft. of water. The contract was awarded to the Midland Land & Improvement Co., who will use the material excavated in filling in a tract of the "Hackensack Meadows" between the Hackensack and Passaic rivers at the point where they empty into Newark Bay, which will cover more than 3,000 acres. Industrial developments are expected to follow on this tract of made land. The channel will be 300 ft. wide from the Kill von Kull to the Nairn Linoleum Works on the Passaic River, and 200 ft. thence to the Greenwood Lake bridge.

REMARKABLY RAPID CONCRETE BRIDGE CONstruction is reported by the McCall Ferry Power Co. The Construction Department of the company is of the opinion that it has made a world's record in this work, or at least come very close to the best existing record. The construction bridge for the McCall Ferry dam is a heavy concrete arch bridge across the York channel of the Susquehanna River at McCall Ferry, Pa.; it is about 900 ft. long, 55 ft. wide, has 22 spans and contains 10,000 cu. yds. of concrete. This was completed in *twenty-two days*. If any better speed records are in existence, we shall be glad to make note of them.

PERSONALS.

Mr. Oscar A. Anderson has been appointed to the Chair of Metallurgy at the South Dakota School of Mines, at Rapid City.

Messrs. Chas. F. Parker, M. Am. Inst. M. E., and C. J. Carroll have opened offices as consulting mining engineers at Parral, Chihuahua, Mex.

Mr. Francis L. Bosqui, M. Am. Inst. M. E., of San Francisco, has been appointed Metallurgical Engineer for the Goldfield Consolidated Mines Co.

Mr. E. G. Holladay has resigned as Engineer of the Nashville Terminal Co., Nashville, Tenn. Mr. H. R. Mauby, Assistant Engineer, succeeds him.

Mr. S. W. Clawson, who recently resigned as Superintendent of the Copper Queen Mining Co., Bisbee, Ariz., has been succeeded by Mr. Parker Woodman.

Dr. C. H. Gordon, of the U. S. Geological Survey, has been appointed to the Chair of Geology and Mineralogy of the University of Tennessee, newly established there.

Mr. John B. Dickson, Chief Engineer of Maintenance of Way for the Baltimore & Ohio R. R., has resigned to become Assistant to the General Manager of the Erie R. R.

Mr. J. A. Purdum has been appointed Superintendent of Bridges, Buildings and Water Supply of the Panama R. R. Co., in the construction of the re-located line. His office will be at Colon.

Mr. G. A. Brothers has been appointed General Manager of the Hudson (Mass.) Electric Light & Power Co. He was for a number of years manager of the light and power station at Hooksct, N. H.

Dr. Charles F. Howard, of Buffalo, N. Y., has been chosen Chairman of the State Prison Commission to select a site for the new State prison to be erected to take the place of Sing Sing prison.

Mr. Samuel H. Brockunier, M. Am. Soc. M. E., formerly Secretary of the Kaaterskill Paving Brick Co., of Catskill, N. Y., has been appointed Manager of the Green Mountain Mining Co., of Silverton, Col.

Mr. R. Whitman, Assistant Civil Engineer, U. S. N., has been relieved from duty at the Bureau of Yards and Docks and transferred to the League Island Navy Yard. Mr. C. A. Bostrom, Assistant Civil Engineer, is transferred from the Bureau to the Puget Sound Navy Yard.

Mr. Geo. A. Clarke, Vice-President and General Manager of the Colorado Southern, New Orleans & Pacific R. R., has been elected Vice-President and General Manager of the St. Louis & San Francisco R. R., New Orleans and Texas divisions. The latter system has absorbed the former.

Mr. Wm. Titcomb Blunt, M. Am. Soc. C. E., has resigned as Superintendent for G. H. Breymann & Bros., contractors, of Boston. Previous to his connection with that firm Mr. Blunt was U. S. Civil Engineer in charge of river and harbor work, etc., over the western end of Lake Erie, under Lieut. Col. Dan Kingman, Corps of Engineers.

Mr. F. B. Maltby, M. Am. Soc. C. E., Principal Assistant Engineer on the Panama Canal, has resigned to become Chief Engineer for Dodge & Day, engineers and constructors, of Philadelphia. He is a graduate of the University of Illinois, Class of '82, and has been engaged in railroad construction, municipal engineering, irrigation and canal work.

Messrs. A. E. and T. K. Legaré have opened offices as consulting civil engineers at 1422 Main St., Columbia, S. C., under the firm name of Legaré & Legaré. Mr. A. E. Legaré was formerly connected with the South Carolina Public Service Corporation, in charge of surveys for its electric railway lines in the state; Mr. T. K. Legaré has been Assistant City Engineer of Columbia for the past 18 months.

Prof. W. F. M. Goss, whose recent connection with the University of Illinois we announced on July 25, will be Director of the newly organized School of Railway Engineering of that institution, as a part of the College of Engineering. Four professorships have been established: railway civil engineering, railway mechanical engineering, railway electrical engineering and railway administration.

Mr. Ralph Mackenzie, of Negaunee, Mich., has been appointed Chief Engineer of the Government's coal mines in the Philippine Islands, by Secretary of War Taft. His headquarters will be on Batan Island, where the principal U. S. coaling station will be located. It is expected that this island will yield the greater part of the coal required; extensive explorations and diamond-drill examinations are to be made.

Obituary.

Wm. Walker Colket, of Strafford, Pa., once President of the old City Passenger Ry. of Philadelphia, died at his home in Strafford on Aug. 24. He was 67 years of age.

Wm. H. De Wyse, of Long Branch, N. J., died on Aug. 21 at his home there. He was a civil engineer, and a banker as well; was prominent in New Jersey road-building, and a member of the Good Roads Congress. He was born in Long Branch, and was 52 years of age.

Emlen Hughes, of Philadelphia, President of the Southern Pine Co., and well known in Philadelphia business circles, died on Aug. 25 at the age of 62. In the late 60's he was a civil engineer, and built the Wilmington & Northern R. R., running from Wilmington, Del., to Coatesville, Pa. Later he entered the lumber business with Geo. W. Bush & Sons.

Oren Root, for 27 years Professor of Mathematics and Natural Sciences at Hamilton College, Clinton, N. Y., died at Utica on Aug. 26 at the age of 69 years. He graduated from Hamilton in 1856 and was the author of a treatise on Trigonometry. He was a brother of the Secretary of State, Elihu Root, and his son, Oren Root, Jr., is Vice-President of the Metropolitan Street Railway Co., of New York City. A wife, two other sons and two daughters also survive him.

Frederick Henry Short, a veteran railroad man of Cincinnati, died there on Aug. 24 at the age of 82. He was born in Middletown, Conn. He began his railroad career with the Cincinnati, Hamilton & Dayton Ry. as a junior clerk, served as a conductor and as a paymaster, and in 1857 was made Secretary and Treasurer. In this capacity he served until 1874, when he was elected President of the road. He retired from that office in 1877, and again resumed the office of Secretary and Treasurer, which he held until his retirement from active service in 1905.

Galen W. Pearsons, M. Am. Soc. C. E., of Kansas City, Mo., died at his home there on Aug. 19. He was born in Ogdensburg, N. Y., in 1832, and became a shipbuilder on the St. Lawrence River there at an early age. Later he became a civil engineer and constructed the waterworks system at Rockaway Beach, N. Y. From 1873 to 1887 or later Mr. Pearsons was virtually Chief Engineer of the National Water-Works Co., and as such designed, built and extended the water-works of Kansas City, Mo. He was also connected with the works later on after their purchase by the city. Since 1897 he has been connected with City Engineering Department in various capacities. He superintended, during his connection with the National Water-Works Co., the construction of water systems at Bangor, Me.; Leavenworth, Kan.; Marshall, Mo.; Ft. Riley, Kansas, and Memphis, Tenn. Mr. Pearsons was a contributor to Engineering News, as far back as 1880; his description of the Kansas City waterworks will be found in our issue of Nov. 5, 1887.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL IRRIGATION CONGRESS.
Sept. 2-7. Fifteenth annual convention at Sacramento, Cal. Secy., Hon. D. H. Anderson, Illinois.

TRAVELING ENGINEERS' ASSOCIATION.
Sept. 3-6. Annual convention at Chicago, Ill. Secy., W. O. Thompson, care N. Y. C. & H. R. R. R., East Buffalo, N. Y.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 10-12. Annual convention at Hot Springs, Va. Secy., Ernest H. Davis, Williamsport, Pa.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 10-13. Thirty-eighth annual convention at St. Paul, Minn. Secy., A. P. Dane, Reading, Mass.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 10-17. Annual convention at Niagara Falls. Secy., F. W. Raven, 315 Dearborn St., Chicago.

CANADIAN ELECTRICAL ASSOCIATION.
Sept. 11-13. Annual convention at Montreal. Secy., T. S. Young, Confederation Life Building, Toronto.

LEAGUE OF AMERICAN MUNICIPALITIES.
Sept. 18-20. Eleventh annual convention at Norfolk, Va. Secy., John MacVicar, 18 Broadway, New York City.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Sept. 30-Oct. 4. Thirty-fifth annual meeting at Atlantic City, N. J. Secy., Dr. Chas. O. Probst, Columbus, Ohio.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 1-4. Annual meeting at Detroit. Secy., Geo. W. Tillson, 831 Ocean Ave., Brooklyn, N. Y.

NATIONAL ASSOCIATION OF RAILWAY COMMISSIONERS.
Oct. 8. Annual meeting at Washington, D. C. Secy., Edw. A. Moseley, Interstate Commerce Commission, Washington, D. C.

RAILWAY SIGNAL ASSOCIATION.
Oct. 8-10. Twelfth annual meeting at Milwaukee. Secy., C. C. Rosenberg, Lehigh Valley R. R., South Bethlehem, Pa.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION.
Oct. 8-10. Nineteenth annual convention at Atlanta, Ga. Secy., J. D. Farasey, Forest St. and Erie Ry., Cleveland, O.

AMERICAN ELECTROCHEMICAL SOCIETY.
Oct. 10-12. Annual fall meeting at New York City. Secy., Prof. J. W. Richards, Bethlehem, Pa.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.
Oct. 14-18. Annual convention of this and affiliated association at Atlantic City, N. J. Secy., Bernard V. Swenson, 29 West 39th St., New York City.

AMERICAN STREET AND INTERURBAN RAILWAY ENGINEERING ASSOCIATION.
Oct. 14-16. Annual convention at Atlantic City, N. J. (See preceding item.) Secy., S. W. Mower, Southwestern Traction Co., London, Ont.

ASSOCIATION OF RAILWAY SUPERINTENDENTS OF BRIDGES AND BUILDINGS.
Oct. 15-17. Annual meeting at Milwaukee. Secy., S. F. Patterson, Concord, N. H.

AMERICAN GAS INSTITUTE.
Oct. 16-18. Second annual meeting at Washington, D. C. Secy., Jas. W. Dunbar, New Albany, Ind.

NATIONAL IRRIGATION CONGRESS.—The Congress will meet at Sacramento, Cal., Sept. 2 to 7, instead of as formerly noted in this column.

The four primary objects of the Congress are "to save the forests, store the floods, reclaim the deserts and make homes on the land." Attendance is not limited, but is expected to include engineers, foresters, National and State officials, business men, editors, etc.

Simultaneously with the Congress there will be held at Sacramento an interstate exposition of irrigated land products and forest products. Aside from discussion of topics relative to irrigation and reclamation, by representative men, visits of inspection will be made to works and projects now under way in the State of California, and to San Francisco to inspect the rebuilding of that city. The mining districts of the State will also be visited. Specific irrigation projects scheduled for inspection are the Yuma project and Imperial Valley; the Klamath project, on the Oregon-California line; the Truckee-Carson project, Nevada; and the Sacramento and San Joaquin Valleys, already centers of irrigation.

Well-known engineers of the U. S. Reclamation and Forest Services will present papers before the Congress.

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